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POWER

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Index to Advertisers, 39.

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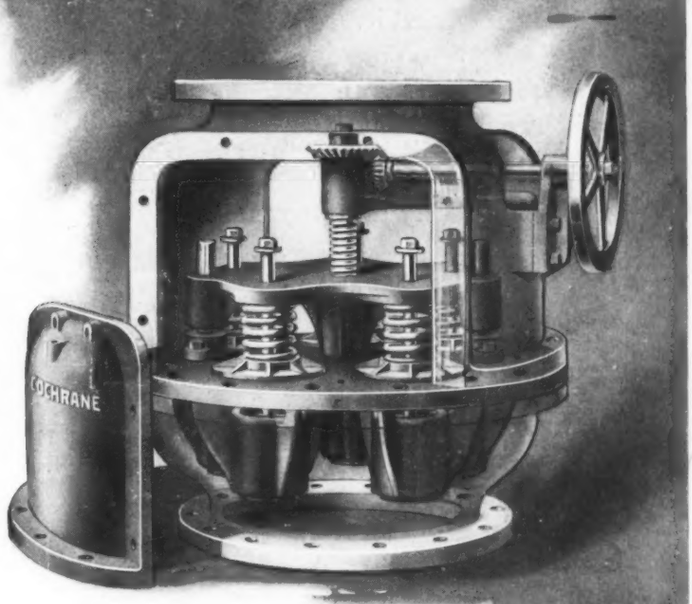

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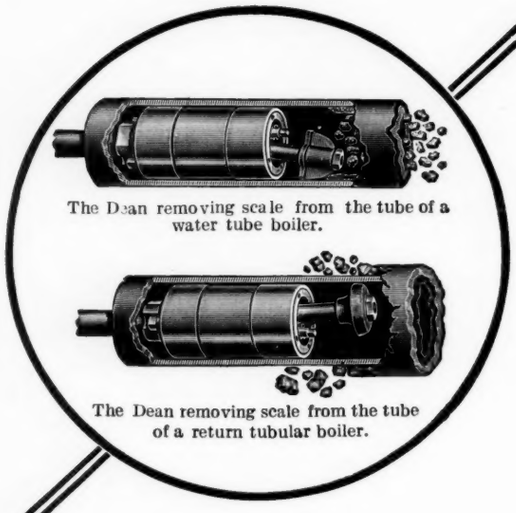

The Dean removing scale from the tube of a water tube boiler.

The Dean removing scale from the tube of a return tubular boiler.

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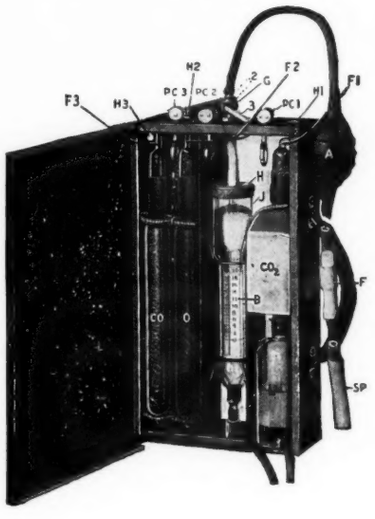
The percentage of CO_2 will show you whether you are moving in the right direction. And every time you shove up the CO_2 a peg, you save more fuel. The *Hays Improved Gas Analysis Instrument* will give an engineer a fuel-saving ability that will influence advancement in position and salary. Suppose you write us *today* and find out what a simple, practical thing flue gas analysis is and how easily *YOU* can become an owner of one of our instruments.



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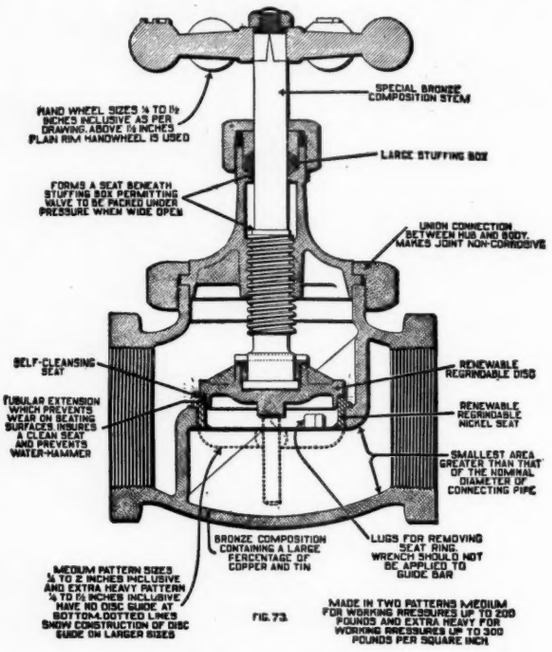
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FIG. 73.
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And no matter what your feed water conditions may be Dearborn Treatment accomplishes continuously satisfactory results.

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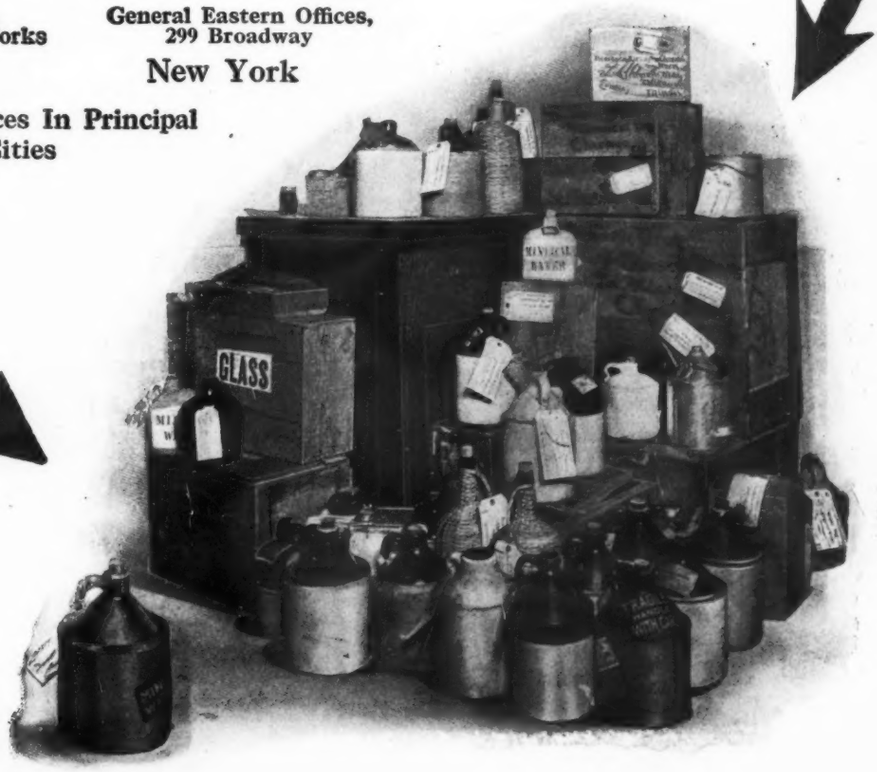

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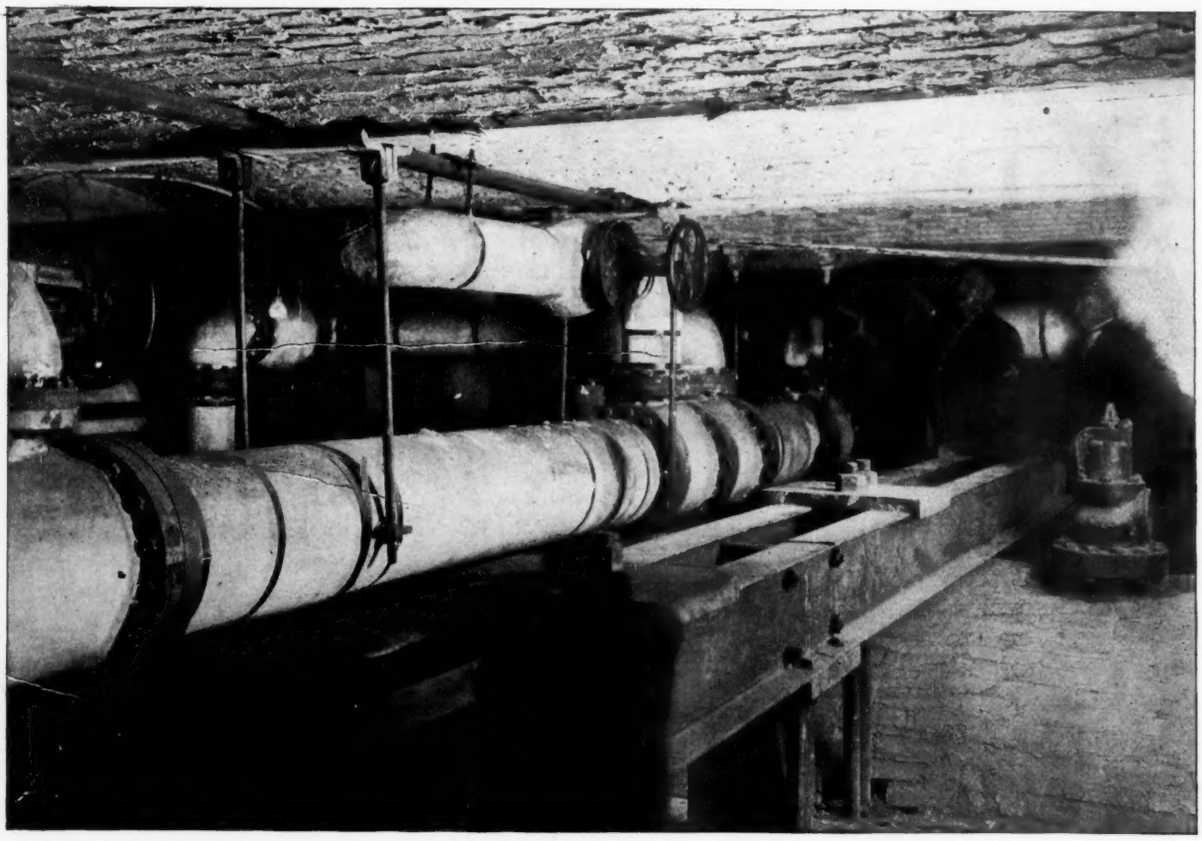

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Engineer in Charge,
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POWER

Vol. 35 NEW YORK, FEBRUARY 20, 1912 No 8

RECENTLY one of our readers related the following story which points its own moral:

"The owners of a plant I visited a few weeks ago look upon their engineer as a necessary evil—*which they endured at the lowest possible cost to themselves.* This engineer is paid wages barely enough to keep him on the job, but not enough to satisfy him that he is receiving fair pay for what he knows and the amount of work he performs. Consequently, he cannot settle down and take the interest in his work that he should and would if he were getting slightly better wages and a little considerate attention.

"He has to order supplies—waste, oil, packing, etc.—weeks ahead, keep after the owners until he gets them, and then the material is always of the very cheapest grade.

"Once, this engineer requested to be supplied with a steam-engine indicator. He was flatly refused. No amount of argument would convince the owners that such a thing was at all necessary.

"Now, these same owners often wondered why a neighboring plant of about the same capacity and equipment can run with operating expenses 40 per cent. lower. I learned that the engineer of this other plant had been discharged by the first people two or three years ago—for incompetence, so they told me. Having the time to spare, I decided to visit the other plant. I would that the owners of the first plant had gone with me. They would have learned a lesson which would have been worth hundreds of dollars to them.

"I found the engineer, a young man in the early thirties, sitting in the engine room looking over his technical paper. He gladly showed me about. Everything about the plant was clean and neat. The engines were running quietly and the boiler settings and the piping seemed to be in the pink of condition. A neat steel locker stood in one corner and contained such supplies as packing and waste.

"A barrel of oil was delivered while I was present. The engineer tested a sample and the barrel was rejected as not up to previous grade. He explained that the policy of this plant was to get good oil, packing, etc., as they cut down repair work and expense.

"The engineer handed me a set of indicator diagrams that had been taken only a few days before; they showed that the engines were properly adjusted and in good operating condition.

"He said that he had only to explain to the owner the purpose of the indicator when one was gotten at once. Not only this, but the owner has become quite an indicator expert himself and can take a diagram, figure the horsepower and understand what the diagram tells.

"This engineer receives $5 per week more than the other. I could see long before I left how the people at this plant are able to operate it for so much less than it costs the other people. In the one plant they buy cheap supplies, and are buying all the time. In the other, they buy the best for their conditions and hence buy seldom. In one plant the engineer is always making repairs—his work is never done. In the other, the engineer has time in which to study and better fit himself to look out for his employer's interest."

Water Power Development in Ohio

By E. F. Baker

A series of five plants totaling 14,000 kw. in capacity will be erected on the Maumee River and its tributaries. The energy developed will be sold within a radius of 50 miles from Columbus.

When the present comprehensive plans of the Auglaize Power Co. have been fully developed, five hydro-electric plants will have been erected and for their power will draw on the waters of the Maumee River and its tributaries, which have their outlet in Lake Erie. These waters constitute the drainage for an area of more than 6000 square miles and this enormous power, which has heretofore gone to waste, will then be utilized for driving machinery in factories in the various municipalities all along the valley, and to the operation of numerous interurban electric roads which traverse this territory.

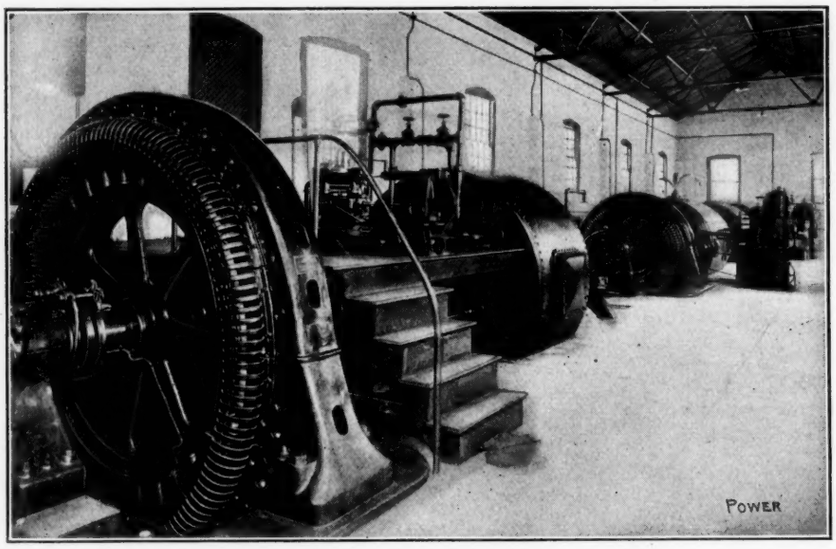


FIG. 1. GENERATING EQUIPMENT AT MAUMEE PLANT

The first of the series of hydro-electric plants has already been constructed at Maumee, Ohio, about 10 miles from Toledo, and is now in successful operation. The next plant was erected on the Auglaize River, near Defiance, and is still in the course of construction, while the others will be located at Oakwood, Melrose and Antwerp. Not only are the waters of the Maumee and Auglaize Rivers utilized but also the surplus waters of the Grand and Loramie reservoirs, near St. Mary's, Ohio, the former being the largest artificial body of water in the world, and the surplus waters of the Miami & Erie Canal.

A few years back, a company was formed and the old Detwiler water-power plant near Maumee, a one-wheel water unit with an auxiliary steam plant of approximately 800 hp., was installed and for some time operated an interurban belt-line railroad and other properties in that vicinity. The project was not wholly successful, however, and the plant was finally shut down. The Maumee Valley Electric Co. was then organized and secured this plant which became the nucleus of the first development and the site of the first hydro-electric plant. Some of the machinery originally installed was used in the new venture.

From the broad reaches of the Maumee River at Toledo, the Miami & Erie Canal ascends around the rapids above the city by a series of locks leading to a level section 23 miles in length and fed from the storage reservoir impounded by the New Grand Rapids dam built by the state a couple of years ago. The location of the Miami & Erie Canal, about 1800 ft. from the Maumee River, made a natural site for the hydro-electric plant which was ideally perfect, cutting down expense in a most obliging manner, as the Grand Rapids dam made a dam at the plant unnecessary.

The canal bed was dredged to a uniform depth of 7 ft., the entire distance between Grand Rapids and Toledo. The company also blasted out a rock bar which impeded the flow of water in the canal near Waterville, thus gaining a material increase in volume.

There is a drop of 621 ft. in the 1800 ft. between the canal and the Maumee River. The level from which the water is drawn for the plant is 18 miles long from the intake at Grand Rapids to Lock 45, which is a mile below the plant. This gives a reservoir of about 18 miles in length. A new forebay was built with the necessary headgates for handling the water from the canal. From the headgates the water passes through iron pipes 7½ in. in diameter directly into the wheels, their draft tubes discharging into the river.

The power house includes the new waterwheel structure, 110x30 ft., and the old combination plant building, 70x 200 ft., containing the boilers and engines originally installed. The new building has concrete foundations set solidly upon bedrock, with walls of brick and steel trusses supporting the roof.

In this building were installed two 750- and one 450-kw. Allis-Chalmers three-phase, 60-cycle, 2300-volt gener-

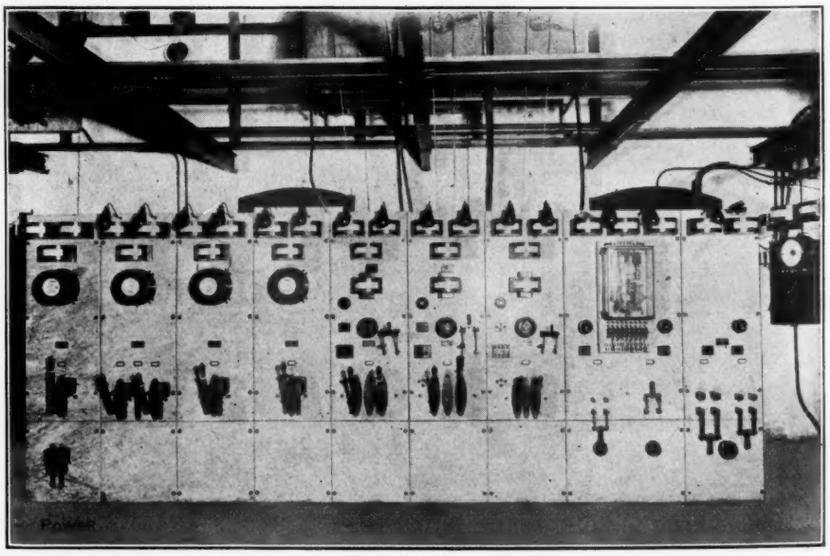


FIG. 2. SWITCHBOARD AT MAUMEE PLANT

ators. The 750-kw. machines are direct-connected to Allis-Chalmers horizontal hydraulic turbines of 1000 hp. capacity each. The 450-kw. machine is direct-connected to a Leffel wheel of 650 hp. capacity and also to a countershaft operated by a 600-hp. Hamilton Corliss tandem-compound engine. The engine

FIG. 3. AUGLAIZE RIVER IN FLOOD

and Leffel wheel can be operated singly or together at will. The exciters for the small machine are belt-driven while those for the two larger units are direct-connected to their own generators.

The operating platform is situated at one end of the power house and here are located one 500- and one 300-kw. 60-cycle General Electric rotaries which supply current for the Maumee Valley belt-line interurban railroad, 18 miles long, which passes in front and in close proximity to the plant. All the leads from the generators are carried through fiber conduits under the floor of the switchboard gallery which is part of the operating platform. These cables are carried up through the floor into type K three-pole General Electric oil switches.

The current is carried to the 2300-volt busbars located above and at the rear of the board from the oil switches. The feeders from the busbars pass through the same type of oil switches to the transformers for the rotaries and the high-tension distribution. The alternating-current operating voltage of the rotaries is 370. The outgoing high-tension lines carry 13,200 volts. There are two banks of these high-tension transformers and each bank is provided with disconnecting switches. The recording instruments were furnished by the Westinghouse Electric & Manufacturing Co., and all other instruments on the board by the Wagner Electric Manufacturing Co.

The operation of the Allis-Chalmers hydraulic turbines is controlled by the new type I oil governor. The Leffel wheel is controlled by an old type Lombard governor. The steam plant, installed as an auxiliary and to be used in case of urgent necessity, is equipped with four 200-hp. boilers.

At Defiance, Auglaize development No. 1, which is located about 3½ miles above the city on the Auglaize River, is nearing completion and will be in operation, it is expected, within a few months. The installation has not yet been made as the machinery is only partly finished. The power house is 230x35 ft. and 45 ft. to the roof trusses. Here four 1000-kv.-a. Allis-Chalmers, three-phase, 25-cycle generators will be installed and provision will be made for an extension of the plant to another unit of the same capacity as the first.

At this place it was necessary to erect a dam 600 ft. long with an 800-ft. retaining wall on the west side of the river. The dam will be 35 ft. high and the power house will be located at its eastern end. This dam will back up the water for about 15 miles, where the waters of the Grand and Loramie reservoirs will empty into the reservoir. This will assure plenty of water at the times of the year when the river is low. The dam itself is of hollow-concrete construction, which is considerably cheaper than the solid concrete and pronounced by experts just as safe. This is anchored into the blue limestone which forms the river bed by concrete walls 11 ft. deep and has a reinforcement of steel rods. Throughout the length of the dam vertical supports are placed every 15 ft., with an angle on the upstream side of 45 deg. On the angle there is placed the deck which is 2 ft. thick. The crest of the dam is 6 ft. wide and 2½ ft. thick.

Below the power plant now under construction will be installed an auxiliary steam plant to be used in case of trouble with the hydro-electric plant.

As previously stated, the Auglaize development No. 1 at Defiance has a capacity of 4000 kw., and the plant at Maumee, 2000 kw. The next plant to be built, that at Oakwood, will have a capacity of 2500 kw., the Melrose installation will have a capacity of 2500 kw. and the one at Antwerp 3000 kw. The cost of the plant at Defiance, including the transmission lines 5 miles above the city, is $125 per kw.

FIG. 4. EASTERN END OF DAM AT DEFIANCE

Pittsburg Smokeless

Because of the substitution of hydro-electric power for coal, a smokeless future is predicted for Pittsburg. There have been reports that Niagara Falls, under the international waterways treaty which goes into effect Mar. 1, would furnish the power, but coal is too cheap in Pittsburg for Niagara-generated electricity to compete with successfully.

Joseph R. Paull, of the Joseph R. Paull Investment Co., predicts, however, that the water of local rivers will provide plenty of power. It is planned, among other things, to dam the Clarion and Tionesta rivers for power uses. Three dams are to be built to form a reservoir or lake 52 miles long on the Clarion River. The plans which are now being considered by the water-supply commission at Harrisburg contemplate an expenditure of $10,000,000. It will be several years, however, before power can be supplied after work on the reservoirs is begun.

Firebrick Furnace Arches

By A. E. Dixon

Many failures of firebrick arches are due to poor workmanship in building them. Suggestions are given as to the proper mortar to use and how to lay the brick, together with calculations for determining the various dimensions.

Trouble with arches when exposed to intense heat is usually due more to the fact that few bricklayers are posted on the laying of firebrick, than to the firebrick itself. The inexperienced bricklayer seems to have the idea that his trowel is necessary on firebrick work, when in reality all that he needs is his "scutch" or hammer.

Fireclay mortar must be very thinly mixed. Occasionally an attempt to describe it in the specifications reads: "Mixed to the consistency of a thin gruel." Within limits, the thinner it is, the better. A thin batter that will flow readily is a better description. Pails are used to carry this mortar and the bricklayers should be supplied with tubs.

The brick should be dipped in the mortar in such a way that the surface to be exposed to the flame or heat and two-thirds of the surface in the wall do not receive any mortar. The back of the brick and the rear third of the wall surface only are covered with the mortar. The bricks must be hammered up tight to each other and the seams on the face of the wall should be very thin—too thin to admit a jack-knife blade; the fire-face of all seams must be slightly open. These open seams are necessary in order to permit the fire-face of the brick to expand slightly when heated.

Fireclay

The fireclay used for mortar should be the same clay as used in the brick. Raw or unburnt clay is frequently used, but the best mortar is made from a mixture ranging from 20 to 30 per cent. of raw clay and 70 to 80 per cent. from old firebrick ground for this purpose. The two kinds of clay are thoroughly mixed before they are wet. The mortar should be mixed with water in a tank or tub and allowed to stand at least 48 hours before it is used.

Boiler Furnaces

Taking a lesson from heating-furnace construction, it has frequently seemed to the writer that boiler furnaces could with advantage be constructed along similar lines, the face of the walls from the grate to the top of the fire, or a few inches more, being faced with either chrome or magnesite brick. These bricks are extremely refractory, and for boiler use the chrome brick would probably be the better. Chrome brick should be laid in a mortar of ground chrome ore and magnesite brick in magnesite cement; they should be laid in the same manner as firebrick. Both chrome and magnesite brick are extremely hard and cannot be cut or broken easily. An emery or carborundum wheel will grind them slowly, but it is nearly as hard on the wheel as it is on the brick.

Firebrick Arches

In building arches, centers are necessary. These should be made long enough to take 1½ arch rings, two or more being provided to get the length desired. The amount of centering required will depend upon whether the arch rings are bonded or keyed into each other. Straight rings generally give less trouble in construction and repair than keyed arches. The brick for an arch should be selected so that they will fit in without any cutting, though rubbing the tapered sides of

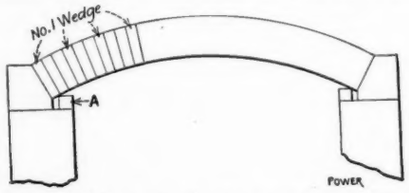


Fig. 1. Showing Straight and Shaped Bricks

two or three bricks may be necessary. Preferably arches should be designed as shown in Fig. 1. The skewbacks should be kept away from the face of the wall and when possible they should be supported entirely independently of the walls and buckstays provided to take the thrust of the arch; then the walls can be finished off so as to protect the lower part of the skewbacks, as shown at *A*. The bricklayer should be provided with a diagram showing the number of shape and straight brick required in each ring and their location, as is marked on a part of the arch in Fig. 1.

Firebrick arches generally have a rise of from 1½ to 2½ in. per foot of span. The flatter the arch, the greater the thrust upon the skewbacks and buckstays and the greater the pressure on the bricks near the spring of the arch. As firebrick are not adapted to carry great weights, particularly when exposed to high temperatures, an arch should be given as great a rise as possible, particularly if of any great length of span. Spans under 4 or 5 ft., however, can be made very flat. The thrust of an arch under a uniform load may be computed by the formula:

$$T = \frac{1.5\, p\, d^2}{h}$$

in which

T = Thrust in pounds per square foot of cross-section per foot of length of arch;
p = Load on arch in pounds per square foot;
d = Span of arch in feet, skewback to skewback;
h = Rise of arch in inches.

In the case of firebrick arches, the weight per cubic foot can be assumed as 130 lb.; this will be the load per square foot if the arch is 12 in. thick. The values of p for thicker or thinner arches are proportionate. The thrust per lineal foot T and the spacing of the buckstays should be such that the tie-rods are not stressed higher than 9000 to 10,000 lb.

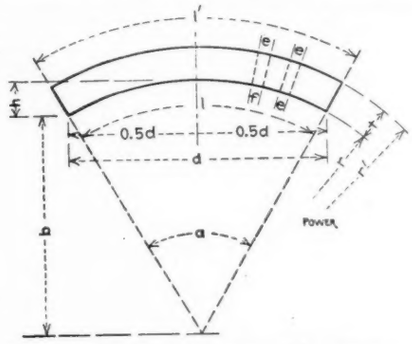


Fig. 2. Diagram Showing Meaning of Letters Used in the Formulas

per square inch. Skewback supports are desirable to carry the arch-thrust between the buckstays. Heavy angle or channel irons are frequently employed. These are subjected to bending stresses and should be worked at very low fiber stresses in order to avoid the racking of the brickwork which would be occasioned if they deflected or sprung very much under the loads placed upon them.

Rise of Arch upon Thrust

In order to illustrate the effect of the rise of an arch upon the thrust, the thrust of an arch 12 in. thick with a span of 12 ft. 6 in., has been computed for four different rises. This span is approximately the width of the firebox under a 600-hp. water-tube boiler.

Rise per Foot, Inches	Thrust, Pounds per Linear Foot
1.0	2,420
1.5	1,630
2.0	1,220
2.5	975

The total rise for these four cases would be 12.5, 18.75, 25.0 and 31.25 in.

respectively, and while the first is so flat that it gives a pressure on the skewbacks of 16.8 lb. (2420 ÷ 144) per square inch, it is not unreasonably high. The other rises would be too high for a coking arch under the tubes of a water-tube boiler, but they would be all right in a dutch oven. It is not desirable to run the pressure on firebrick much over 25 lb. per square inch or 3600 lb. per square foot.

Method to Determine Number of Brick

Knowing the rise of the arch and the span, the following method can be used to determine the number of shape and straight brick required for each ring. The lettering in the formulas and on Fig. 2 is the same. The radius of the arch is found as follows:

$$r = \frac{(0.5\,d)^2 + h^2}{2\,h} \qquad (1)$$

d, h and r being taken in the same units, either feet and decimals of a foot, or inches.

The sine of half the angle of which d is the chord when the radius equals r is found from

$$Sine\ \frac{a}{2} = \frac{0.5\,d}{r} \qquad (2)$$

Reference to a table of the natural trigonometrical functions will give half the angle a, and this multiplied by 2 will give the angle a. If a table of chords is available, the angle can be found by dividing the chord d by the radius r. The accompanying table gives the angles of which the chord is the length of span, corresponding to various rises per foot of span.

Inches Rise per One Foot of Span	Arc, Degrees	Inches Rise per One Foot of Span	Arc, Degrees
$\frac{3}{8}$	37° 0′	$1\frac{1}{16}$	63° 45′
$\frac{7}{16}$	39° 0′	$1\frac{1}{8}$	65° 0′
$\frac{1}{2}$	41° 0′	$1\frac{1}{16}$	66° 0′
$\frac{9}{16}$	42° 30′	2.0	67° 15′
$\frac{5}{8}$	44° 0′	$2\frac{1}{16}$	68° 15′
$\frac{11}{16}$	45° 30′	$2\frac{1}{8}$	69° 15′
1.0	47° 0′	$2\frac{3}{16}$	70° 15′
$1\frac{1}{16}$	48° 30′	$2\frac{1}{4}$	71° 30′
$1\frac{1}{8}$	50° 0′	$2\frac{5}{16}$	72° 30′
$1\frac{3}{16}$	51° 30′	$2\frac{3}{8}$	73° 30′
$1\frac{1}{4}$	52° 45′	$2\frac{7}{16}$	74° 15′
$1\frac{5}{16}$	54° 15′	$2\frac{1}{2}$	75° 15′
$1\frac{3}{8}$	55° 30′	$2\frac{9}{16}$	76° 15′
$1\frac{7}{16}$	56° 45′	$2\frac{5}{8}$	77° 15′
$1\frac{1}{2}$	58° 0′	$2\frac{11}{16}$	78° 15′
$1\frac{9}{16}$	59° 15′	$2\frac{3}{4}$	79° 15′
$1\frac{5}{8}$	60° 30′	$2\frac{13}{16}$	80° 15′
$1\frac{11}{16}$	61° 30′	$2\frac{7}{8}$	81° 0′
$1\frac{3}{4}$	62° 30′	$2\frac{15}{16}$	82° 0′

The lengths of the arcs measured along the upper and lower surfaces of the arch are found by the same formula, the radius in one case being that of the under side of the arch and in the other that of the upper surface of the arch. The formula given here is for the under surface.

$$l = \frac{6.283\,r \times a\ (in\ degrees)}{360} \qquad (3)$$

If r is in feet, l will be in feet. For convenience in figuring, a should be in degrees and decimals of a degree.

The difference in the lengths of the inner and outer surfaces of the arch is the amount which must be taken up by the taper of the total number of shape brick required; denote this difference by k. Then

$$l' - l = k \qquad (4)$$

and

$$e - f = g \qquad (5)$$

In which:

e = Thickness of large end of tapered brick.

f = Thickness of thin end of tapered brick.

g = Difference in thickness between the two ends of the brick.

Furthermore

$$\frac{k}{g} = n' \qquad (6)$$

the number of shape brick required for the arch. And

$$\frac{l}{e} = n \qquad (7)$$

the total number of brick required for the arch.

$$n - n' = n'' \qquad (8)$$

are the number of straight brick required for the arch.

The shape brick should be arranged to form a symmetrical curve by separating them from each other by straight brick; that is, if an equal number of shape and straight brick are required, they will be placed alternately, but in flat arches two or three straight brick may have to be placed between each shape brick. That shape brick should be selected which will give the smallest number of straight brick, as it is not desirable to separate the shape brick with more than two straight ones.

Troubles with White-Metal Bearings

By E. F. Butler and J. N. Kilby

A large steel works, having experienced trouble from bearings run with anti-friction metal, called in the writers to investigate and rectify the trouble. The principal faults were short life, spreading or pounding out, breaking up in the shell and cutting and scoring of the shafts.

The practice of the firm was to buy its bearing metals on a given chemical analysis. Therefore, a number of bearings that had failed during service were analyzed to see if they came up to specifications, and various results were found in bearings from the same delivery. To push the matter still further, samples were taken from one bearing and found to differ from end to end. As a typical example, a bearing which should have contained 2 per cent. antimony had only 0.5 per cent.; the tin also varied.

We resolved to effect some improvement in melting and running up, and built a furnace for that purpose. This consists of four cast-iron plates clamped together and lined with a good quality of firebrick. Across the bottom, bars are placed, and near the top of the back wall a short flue connects with a stack which should not be much less than 20 ft. long and 6 in. diameter. The cover is formed by several firebrick laid side by side and clamped together, and the metal is melted in a plumbago crucible with a lid of the same material. For ordinary sizes the inside of the furnace can be three times the diameter of the crucible in width and twice its height. The furnace should be started by a coal fire and half filled with 2-in. hard coke free from dust. The cover is placed on and when the coke has taken fire thoroughly, all traces of the coal should be removed. Next break up the white metal and place it in the crucible with alternate layers of charcoal and cover the top with more charcoal. Place the lid on and put in the furnace, ram the coke tightly and put the cover on the furnace. Forty pounds were melted easily in as many minutes, although air under pressure between the bars will hasten the action. It may be mentioned that this is the stage at which more bearings are spoiled than at any other.

Even in important concerns, the running of bearings is often left entirely to the workman. Metal from the stores is used with trimmings from previous casts, borings from the lathe often mixed with brass and other turnings are all melted in a dirty ladle at the first fire that comes handy. The metals which melt first will vaporize and a loss of metal will result. This is particularly so in the case of tin, which has a very low melting point, and as it has high lubricating qualities and, moreover, is comparatively expensive, it is worth while going to some trouble to retain it unaltered.

Another disadvantage of melting in an open ladle is the forming of a scum (oxide) which is sufficient in the finished bearing to score the shaft. By melting in a covered crucible, as described, all these disadvantages are done away with, the result being that the finished bearing gives the same analysis as the unused metal.

As regards the actual running, little need be said. Warm the shell of the bearing previously so that it can barely be touched. The larger the shell the more important this is. When a core is used have it as smooth as possible. By holding it over a smoky flame until it becomes covered with soot it will leave a smoother surface and not stick to the metal. Pour the metal as slowly as possible; this lessens the chance of blowholes and gives a solid bearing.

By these methods most of the difficulties were overcome. In some places, particularly in the rolling mills, the life of the bearings was not as long as could be desired, but an improvement was effected by replacing some of the softer metals by an addition of aluminum.

Confession of an Engineer

By R. O. Warren

Using information published in an advertisement, the engineer is enabled to show Manager Wood that he is onto his job.

He also puts one over on the smoke inspector by challenging his reports and proving that they were false by means of a chart taken from an automatic smoke recorder.

My work and Manager Wood gave me no trouble for several weeks after putting the strainers on the pump-suction pipes. In the meantime cold weather had come, the boilers were necessarily fired harder, and occasionally the fireman got careless and there was some smoke.

Violating the Smoke Ordinance

Wood had cautioned me to watch the firemen more closely and to try and pacify the smoke inspector, who, having complained several times, had at last forced the company to pay a fine for violating the smoke ordinance. We had talked the matter over and, although I admitted that the firemen occasionally made some smoke, I did not believe that conditions were as bad as had been claimed by the inspector.

"Well, how are you going to prove it?" was the way Wood came back at me, and I had to admit that I could not.

"Since these complaints began about excessive smoke, I have done a little smoke inspecting myself," said Wood, "but the smoke issuing from our stack is not enough to warrant a fine. I am inclined to believe that the inspector of this district is attempting to hold us up and that his interest in the smoke problem is not based solely on his desire to keep the atmosphere clear and clean."

"Smoke has been made for a good many years," said I, "and we are not the first to be troubled by this nuisance. There have been smokeless furnaces built in which supposedly perfect combustion took place, but the smoke problem is with us just the same. Someone who has taken the trouble to find out claims that nearly 2500 patents have been issued during the past 20 years on smokeless furnaces, and yet with all this display of genius smoking chimneys are by no means abolished."

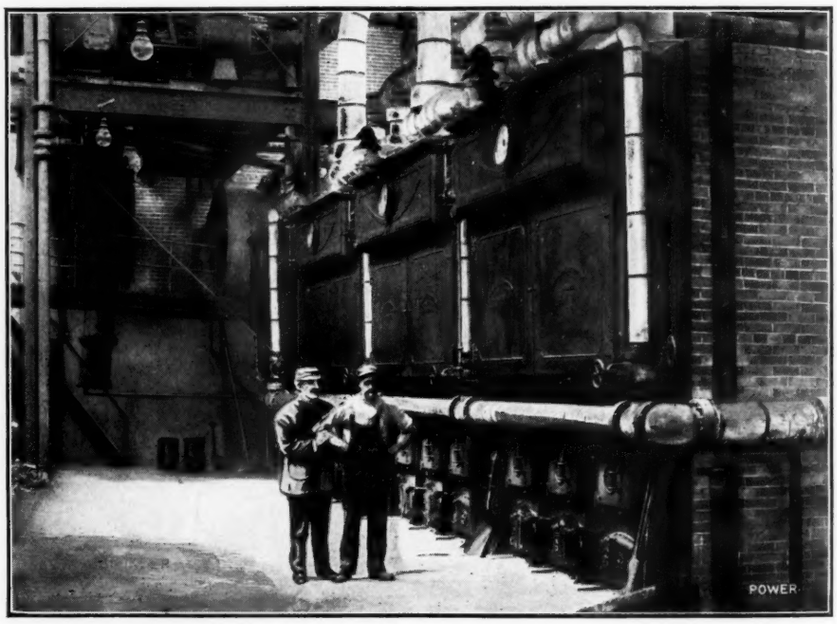
"Well, you don't mean to say that these patent furnaces are of no account, do you?"

"By no means," I hastened to reply. "Many of them are exceptionally meritorious and are built with but few faults, if such a thing can be said of any furnace, but no one of them seems to cure everything, like a patent medicine, and they never will."

"Why not?" asked Wood. "I have noticed that when a man knows what he wants, he usually gets it. I don't see why a smokeless furnace cannot be built just as well as other perfected devices."

Carelessness and Ignorance

"There are two elements which will always be found in the average boiler room, carelessness and ignorance, and they are the two greatest causes for smoking chimneys. Ignorant firemen—and by that term I mean men who do not understand the principles of combustion, how much air to supply to the furnace, and how to handle their fires—are usually the result of failure to properly instruct them in their duties."



I Told the Chief Fireman that the New Smoke-recording Device Would Help Us Get One Over on the Smoke Inspector

"Then that disposes of one of the objectionable elements which work against smokeless combustion," said Wood, as he seated himself in a more comfortable position.

"Yes, but there is the element of carelessness, and this is a mighty hard thing to eliminate. It is human nature and that is difficult to govern. The one way to decrease the carelessness of firemen is to make them understand that their work must come up to a certain standard; that there is a means of showing when and where they are careless and that their work is constantly under supervision.

"If a man is habitually careless, then there is nothing to do but discharge him. Of course," I added, glad to get a come-back at Wood, "you can't expect to have the highest type of experienced firemen, men who understand combustion in all its phases, for $1.65 per day."

"No, I don't expect anything out of reason for that money, but I do expect that the chief engineer will be on the job and will get the best service out of the men in the fireroom." With this shot, Wood looked at his watch, closed the case with a snap and disappeared through the engine-room door toward his office.

Warren Gets an Idea

I was somewhat dazed for a few moments after Wood's retirement. Here was a chance to do something to regain the ground I had lost through neglecting my opportunities and do things that would count. I knew that our slight smoke violation did not warrant a fine, but I could not prove it. And I said to myself: "How can I get one over on the smoke inspector, cut in ahead of Wood and perhaps secure an increase in wages for the fireman?"

As I sat thinking over the matter, unable to formulate any feasible plan for checking the inspector's report, the morning mail, containing a copy of POWER, was brought in by the office boy. In looking over the advertising pages, I saw this headline in an advertisement: "Watch Your Stack and Check Your Fireman!"

That advertisement was inserted by a company making a smoke-recording device, and it claimed that one could tell at a glance how much or how little a

chimney smoked and that a constant record was made as to just how dense was the smoke issuing from the chimney.

"Just the thing!" I exclaimed as I finished reading the advertisement. I wrote for a catalog, which came in due time. Then I familiarized myself with its contents and came to the conclusion that the device was just what I needed, as it would make the firemen more attentive to their work. It would also show them where and when they were making smoke, how much was being made, when it happened and who was responsible.

Putting It Up to Wood

When I had the details of the device well in hand, I sent word for Wood to come down to the engine room and greeted him with, "I've got a stunt to pull off on that smoke inspector that will make him dizzy if you are game enough for the price. It's a smoke-recording device and, as far as I can judge from what the catalog says, it will save its original cost in a very short time."

"I don't see that a smoke recorder will save us any money," said Wood. "If the firemen do their work properly after being carefully instructed, there should be no fine for smoke-ordinance violation."

"Well, that isn't the only way to save money. It occurs to me that you came in here once upon a time and delivered quite a lecture on the money that was wasted through careless firemen. This device will make the men more careful as it records the amount of smoke going up the chimney. Smoke is a sure sign of incomplete combustion; I believe I heard you make this remark some months ago."

"What will this machine cost?" asked Wood, with a slight grin.

"About a couple of hundred, I suppose."

"I'll think it over. There may be something in what you say."

The Smoke Recorder Arrives

I heard no more about the matter until the machine arrived. It was set up and continuous charts were produced each day and filed for future reference. The firemen took kindly to the idea and a friendly rivalry sprang up as to who would produce the clearest chart. In a few weeks the smoke issuing from the stack was so much reduced that Wood said it sent a chill up and down his spine whenever he returned to the plant after being downtown as the smokeless chimney gave the impression that the plant was shut down.

The smoke inspector, however, was still on the job. The old complaints came in at intervals and, finally, a stiff protest and warning came from the chief inspector.

"Now is the time for you to make good with your smoke record," announced Wood the next morning after receiving the notice. "I have objected to the reports of the inspector and have offered to prove that they are false. Get those charts and we will go down to the chief's office and have this smoke business settled so far as we are concerned."

The Inspector Wilts

We proceeded to the chief inspector's office, to which the local inspector had been summoned. After the greetings of the day, the chief said: "Mr. Sawum, the inspector for your district, reports that on Dec. 17 smoke issued from your stack for a matter of 30 minutes between 12 and 12:30 noon in excessive quantities, and on Dec. 21 a similar violation occurred for 20 minutes, or from 2:20 to 2:40 p.m."

As each case was cited I laid aside the chart taken on that date and was gratified to observe that Inspector Sawum looked considerably disconcerted at the sight of them.

Something like a dozen dates when smoke violation occurred were read off and then the chief inspector finished by asking what excuse we had to offer.

"None at all," I answered; "there is none. If there is any explanation needed, it looks to me as if it were to come from your side of the house. For instance, on Dec. 17, between 12 and 12:30, there was no smoke issuing from the stack of our plant," and I produced the chart for that date, which showed that a very thin film of smoke had issued from the stack but a short portion of the 30 minutes stated by the inspector. The chart for Dec. 21 showed but a trace of smoke for the 20 minutes the inspector had reported the chimney to have been in a smoky condition.

In every other instance the charts showed that the inspector had faked his report. After the operation of the machine had been explained to the chief inspector, he halted the proceedings and promised to further examine the inspector's reports.

I think he did, for nothing more was ever heard of the matter and a new smoke inspector was detailed to our district a short time afterward.

Wood's severe lessons deeply impressed me and with the smoke recorder I was enabled to save the company from an unjust fine, show up the smoke inspector, and, best of all, find that the coal consumption had been greatly reduced since the device had been in operation. Wood felt so good over the showing that it was an easy matter for me to get an increase for the firemen.

Norway's great water-power advantages are the means whereby its increasing electrochemical industries will be conducted on a scale impossible in any other European country.

Would Lease Alaskan Coal Lands

In his annual report, recently made public, Secretary of the Interior Fisher recommends "a liberal but carefully guarded leasing law for the development of its mineral resources, and especially of Alaska's coal lands. Its greatest resources are her minerals, and in the development of these the precious metals still hold the predominant place. Careful consideration of the provisions of an appropriate leasing law for the coal lands of Alaska is being continued through the Director of the Bureau of Mines, with a view to suggesting such changes in or substitutes for bills on this subject, which are now pending in Congress, as may be desirable."

The Secretary urges also the construction by the government of a central trunk-line railroad from tidewater to the Tanana and Yukon; the reservation of a sufficient amount of the coal lands to provide for the future needs of the navy, this coal to be mined by the government.

"The whole subject of water-power development and control should, in my judgment, receive the immediate consideration of Congress," says the Secretary, "and constructive legislation should be adopted without further delay. I believe the Federal government has adequate constitutional power to control water-power development, both in navigable streams and upon the public domain, and to exact compensation and to impose proper conditions in either case. It is apparent that the Federal government can act more effectively than the states in many cases. No correct or permanent solution of the water-power question can be reached until the interests of the state and of the nation have been reconciled."

Long Acre Co. to Use Diesel Engines

The Long Acre Electric Light & Power Co., of New York City, expects to have its second power plant in operation within five months. The Diesel internal-combustion engine is the type of prime mover to be used, and the first one to be installed will be of 3600 hp. capacity.

It is the intention of the company to install power plants in several parts of the city rather than one central plant with substations.

The Long Acre Electric Light & Power Co. expects to become an active factor in the lighting field on Manhattan Island and in the Bronx within a few months. The Public Service Commission has authorized a bond issue of $50,000,000, of which $4,000,000 has been approved for sale. Within a year the company plans to have in operation five or six plants with an aggregate horsepower of between 25,000 and 30,000.

The Sturtevant Steam Turbine

When we last described the Sturtevant steam turbine it had just made its appearance upon the market. Experience and use have led to the usual adaptations and development, and it will be interesting to review it in its latest form.

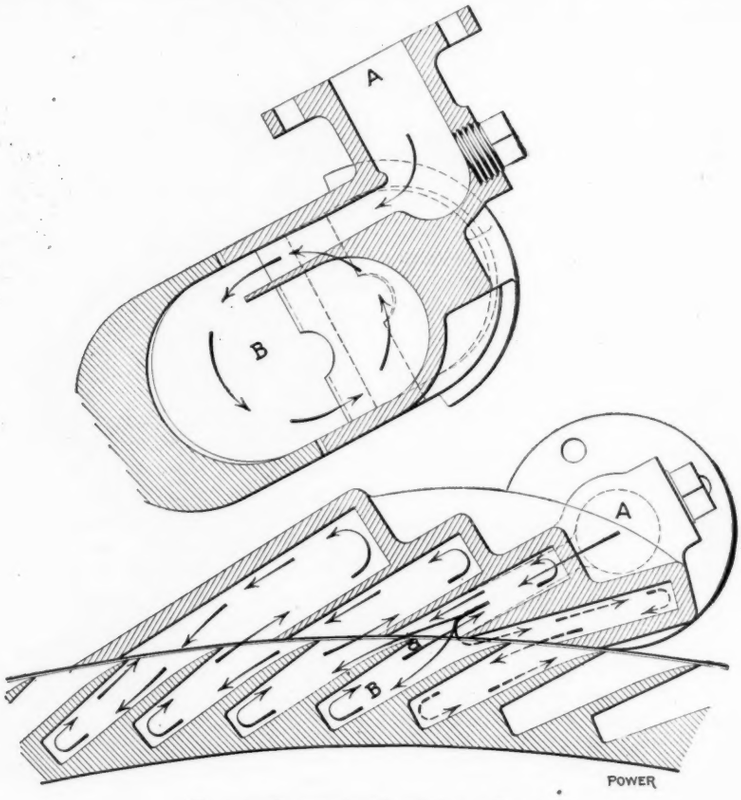


FIG. 1. SHOWING COURSE OF STEAM

This turbine, it will be remembered, is of the Riedler-Stumpf type, where a single wheel, with but one row of buckets, is made to serve for several velocity stages by returning the steam upon the wheel by means of reversing chambers, as shown in Fig. 1, the relation of which to the actual turbine will be made apparent by an inspection of Fig. 2. The steam enters through a nozzle which is designed to expand it to the exhaust pressure. With the velocity acquired by this expansion, it enters the bucket *B*, compelling by its impact the rotation of the wheel of which the bucket is a part, and leaving the far side of the moving bucket with its velocity reduced in proportion to the difference in the velocity of the jet and the wheel.

Suppose the velocity of the jet as it leaves the nozzle to be 2000 ft. per second, and that of the bucket to be 200. Since the bucket is running away from the steam at a speed of 200 ft. per second, the steam will overtake it and pass through it with a velocity, relative to the bucket, of 2000 — 200 = 1800 ft. per second.

Neglecting the effect of friction, it will leave the bucket in the reverse direction, with a velocity of 1800 ft. per second relatively to the bucket. But since it is being carried forward at the rate of 200 ft., its movement relatively to the stationary bucket, which it is now entering, is only 1800 — 200 = 1600 ft. per second. With this velocity it passes through the reversing bucket and is turned around to impinge again upon the wheel.

The energy stored in a moving body is proportional to the square of its velocity. To get all the energy out, the body must be brought completely to rest, but if the velocity is reduced to one-half, three-quarters of the energy will have been extracted. The relations of the velocities and energies in the abstract case which is being considered would be as follows:

	Velocity, Ft. per Sec.	Energy per Pound of Steam	Energy Abstracted, Ft.-Lb.
First impact	2000	62,189	22,388
Second impact	1600	39,801	17,413
Third impact	1200	22,388	12,438
Fourth impact	800	9,950	7,463
Fifth impact	400	2,487	2,487
Discharge from fifth bucket	0	0	

Of course, in the actual turbine the steam cannot be brought absolutely to rest, and the velocity is reduced by other causes than abstraction by the wheel. The energy abstracted by the last impact is relatively unimportant (only about one-tenth of that by the first in the above table). The number of reversals employed will be determined by the initial velocity of the steam, which in turn is dependent upon the initial and exhaust pressures and upon the bucket's velocity, fewer reversals being required for the faster running turbine.

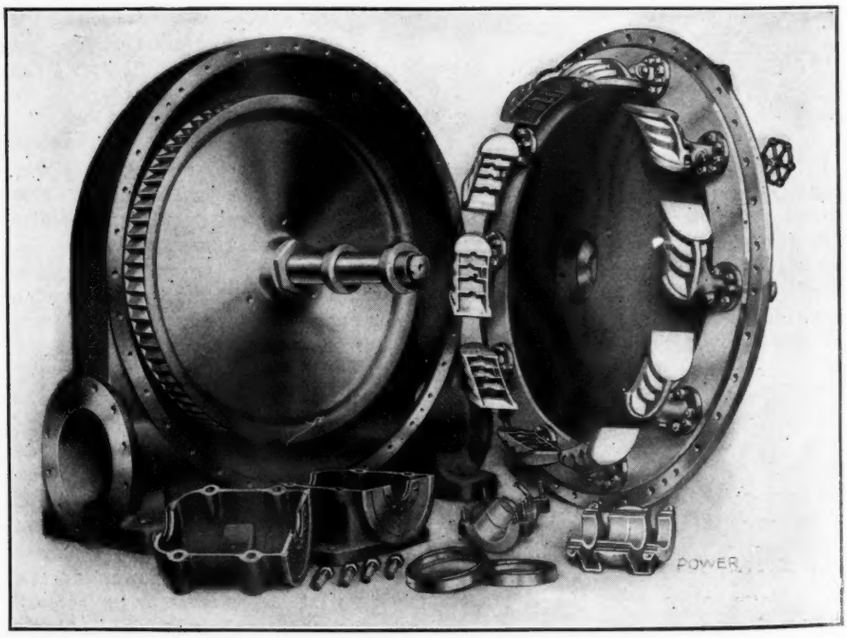


FIG. 2. INTERIOR OF STURTEVANT TURBINE

In explaining a turbine of this type a sketch, like Fig. 1, is usually made with the edges of the bucket and reversing chamber drawn line and line. This is, however, only a momentary or instantaneous condition. The greater part of the time the edge *a* of the first admission chamber will be opposite some part of the bucket entrance, so that a portion of the steam could blow back, as indicated by the dotted arrows, generating pressure and inducing leakage into the exhaust casing if its motion is stopped by making the nozzle block solid at this point. Some builders meet this condition by canting the edges of the stationary reversing bucket so that the discharge end leads to the center of the next wheel bucket.

One feature of the new Sturtevant turbine is a supplemental chamber back of the nozzle chamber, so that any steam

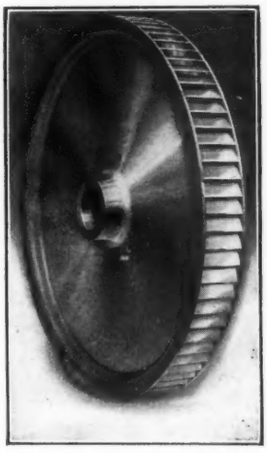


FIG. 4. THE ROTOR

which is diverted in this way will be reversed and thrown back into the wheel. This supplemental chamber is that shown at the right in Fig. 3, the rectangular space at the bottom of the next chamber being the outlet or mouth of the nozzle. Its use is said to have added considerably to the efficiency, especially at the lower speeds or higher steam pressures.

The nozzle blocks, of Tobin bronze, are cast in the form shown in Fig. 3, and are bolted to an annular chamber, forming an integral part of the steam head, as shown in Fig. 2.

This annular chamber, a section of which is visible in Fig. 5 and the exterior in Fig. 6, is the only portion of the turbine to which live steam is admitted. It has no openings except those to the nozzles, which are controlled by valves, as shown in the two views just referred to, and no joints except that of the entering steam flange; the flanges of the nozzles are made up metal to metal and provided with dowels, so that the nozzle will be accurately replaced in case it is necessary to remove it. The semicircular gaps in the partition separating the chambers of the nozzles serve no useful purpose, but are incidental to the machining process, affording room for the arbor of the milling cutter.

The interior surfaces of these chambers and partitions are highly polished to reduce frictional losses, and the cross-section of the chamber is progressively increased to take care of the same volume of steam with the diminished velocity.

The rotor, Fig. 4, is a solid forging of openhearth steel, made to the following specifications:

Phosphorus, not over	0.04 per cent.
Sulphur, not over	0.04 per cent.
Manganese	0.40 to 0.50 per cent.
Carbon	0.20 to 0.25 per cent.
Tensile strength	65,000 lb.
Elastic limit	35,000 lb.
Elongation in 2 in	25 to 35 per cent.

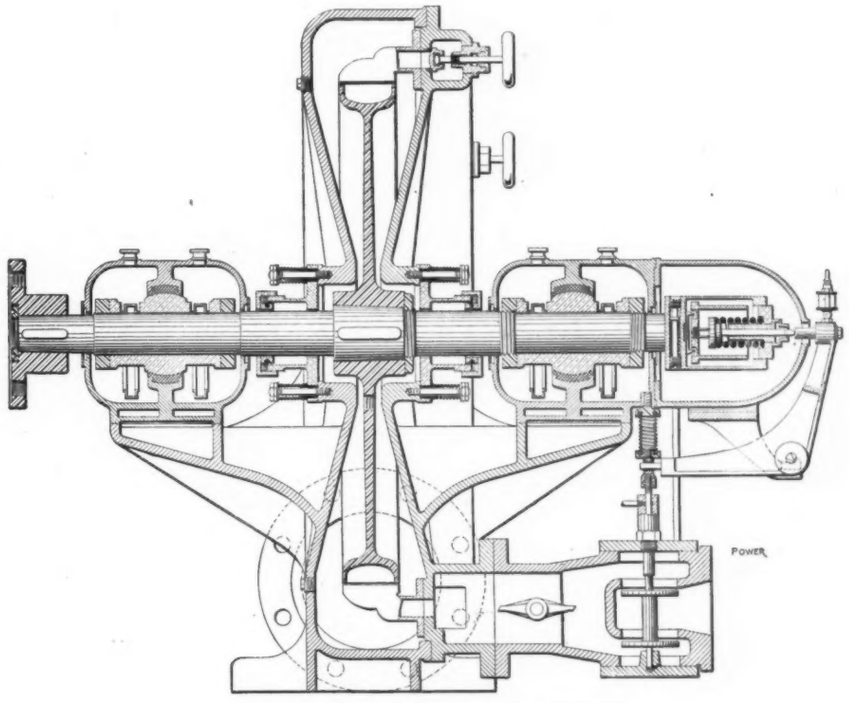


FIG. 5. SECTION STURTEVANT TURBINE

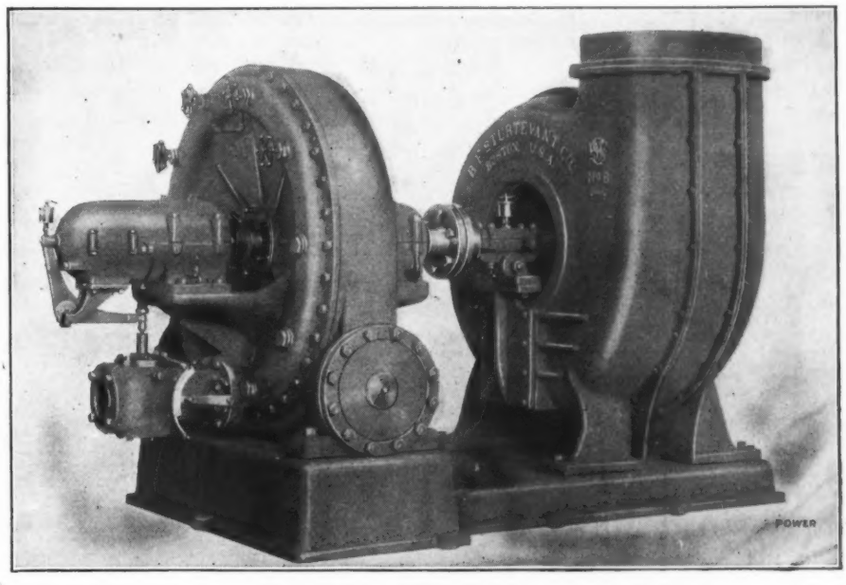


FIG. 6. STURTEVANT TURBINE ATTACHED TO BLOWER

By an ingenious process of milling, in which the cutter is one of a pair of spur gears, the front of the teeth being formed as cutters, the central notch is avoided and the edge of the bucket partition is reduced to a sharp straight line. The same process can, and probably will

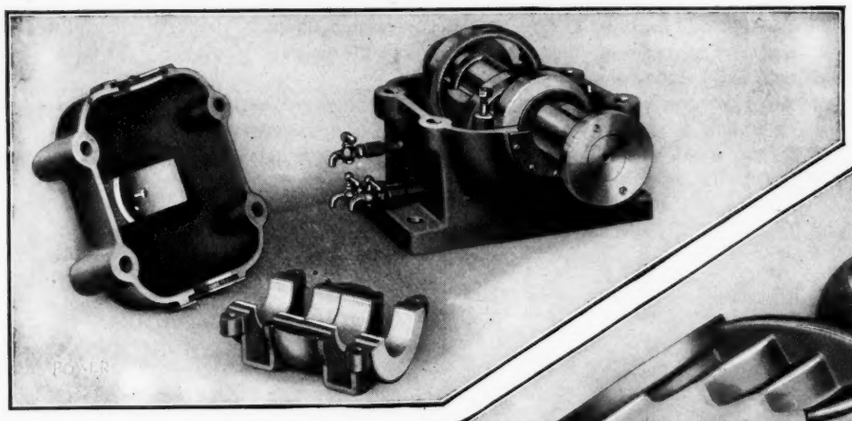


FIG. 7. SPHERICAL BEARING

and 87 of lead molded under heavy pressure into rings which are afterward split. For use with a condenser the packing has a water-sealing groove.

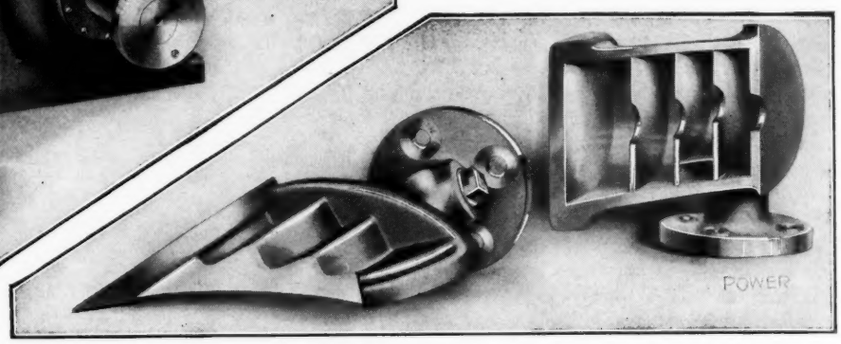


FIG. 3. NOZZLE BLOCKS

be, applied to the milling of the nozzle segments. The side flanges project slightly above the edges of the buckets, shielding them from injury in case of contact. The wheel runs against the faces of the nozzle blocks (as will be seen if the parts shown in Fig. 2 are imagined to be put together) with a clearance of one side of the exhaust casing (that shown in the front of Fig. 6) and plugged holes in the casing permit inspection of the clearances. Two threaded thrust collars on the governor end of the shaft

The bearings are spherical, self-aligning and split horizontally, as seen in Fig. 7 and in the longitudinal section, Fig. 5. They are lined with an alloy containing 91 parts of tin, 4½ of

SIZES AND CAPACITIES OF TURBINE NOW BUILT

Turbine	Diameter of Rotor in In.	Normal Speed, R.p.m.	Normal Capacity, B.Hp.	Turbine-driven Generating Unit, Kw.	Weight		Pipes for Maximum Capacity	
					Turbine Only	Generating Set, Lb.	Steam, In.	Exhaust, In.
A 5	12	2000 to 5000	25	3 to 10	600	1500 to 2085	1¼	4
B 5	18	1800 to 4000	50	7½ to 35	1200	2250 to 3970	2	6
C 5	24	1600 to 3500	100	15 to 50	1800	3685 to 5600	2½	8
D 5	30	1400 to 3000	150	50 to 57	2400	6600	3½	8
E 5	36	1200 to 2500	200	75	3000	7500	4	10

1/16 of an inch, and as the runner is nicely balanced and the design is not such as to allow of unequal expansion, contact of the running parts or injury to the solid integral rotor appears most improbable. The wheel is highly polished all

make it possible to adjust for any changes in longitudinal register.

The rotor is carried upon a 3.5 per cent. nickel-steel shaft, which is ground after being turned. The brackets for the bearings are of a part with the casing, as shown in Figs. 5 and 6. The stuffing-

antimony and 4½ of copper. They are ring oiling, the rings being of channel-shaped section, with a deflector, shown in Fig. 8, to scoop the oil out of the channel and lead it to the bearings under a considerable pressure due to its velocity.

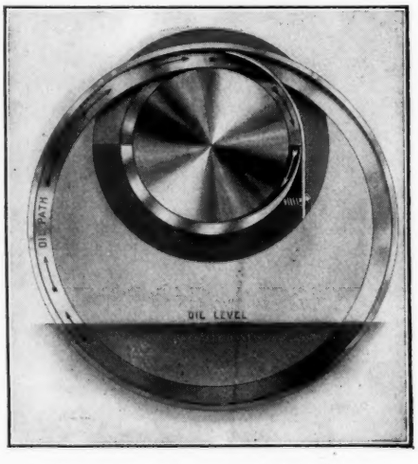


FIG. 8. DEFLECTOR IN OIL RING

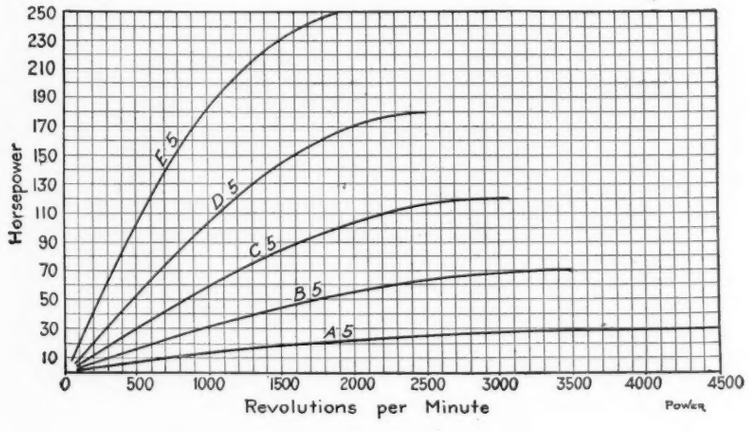


FIG. 9

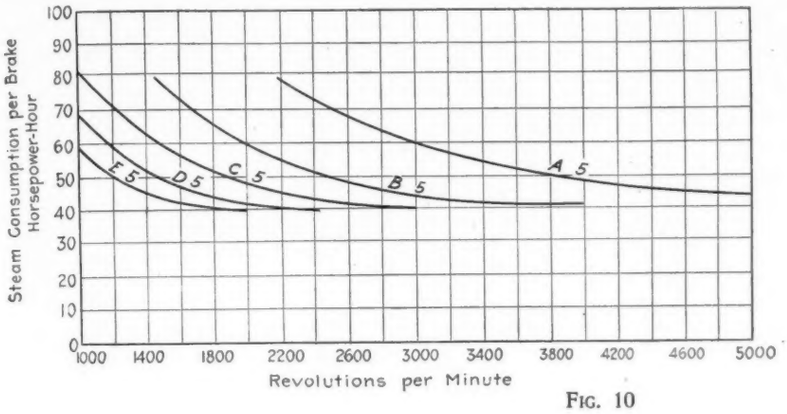
over, an emery belt running upon a pulley narrow enough to be introduced into the bucket spaces permitting even these interior surfaces to be thoroughly finished. The runner may be inspected in position through the blank flange on

boxes are required to carry only the difference between the atmospheric and exhaust pressures and are of a special floating type, filled with a metallic packing consisting of shreds of an alloy containing 5 parts of antimony, 8 of tin

These turbines are now built in the sizes and capacities shown by the accompanying table.

With a given size of runner the capacity is varied within the limits shown by the table and curves, by putting in more

or less nozzles. The capacity increases with the speed up to the limit of the nozzles, and the attainable efficiency with the greater speed is higher. The diagram, Fig. 9, gives the maximum horsepower which the several sizes will develop at different speeds, with 125 lb. gage initial pressure, dry saturated steam and atmospheric exhaust, and Fig. 10 the steam consumption per brake horsepower at the best load under the same conditions. Fig. 11 gives the steam consumption of the various sizes at different capacities. From these three diagrams it is seen that there is a wide range of choice of a turbine to drive a given load, especially if one is not tied to a given speed. With a given speed, minimum steam consumption will call for the larger and more expensive unit. But if, as in cases where the exhaust is used for heating feed water or in manufacturing processes, the steam rate is of secondary importance, a considerable saving in weight, space and investment may be made by choosing a smaller unit.



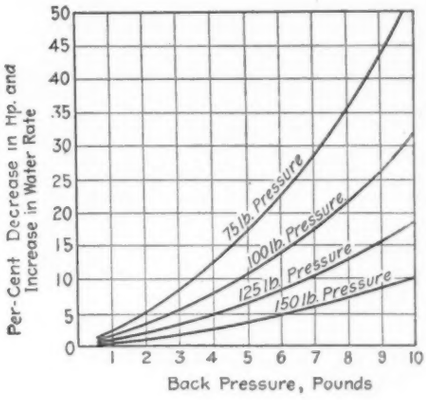

Per-Cent Decrease in Hp. and Increase in Water Rate
Back Pressure, Pounds
75 lb. Pressure
100 lb. Pressure
125 lb. Pressure
150 lb. Pressure

FIG. 10

The supplementary chart at the right of Fig. 10 gives an approximation to the effect upon the water rate of back pressures up to 10 lb., under various initial pressures, the ordinates being decrease in capacity or increase in water rate, expressed in per cent. Moisture in the steam will lower the maximum horsepower and raise the water rate practically 2 per cent. for every per cent. of moisture. For instance, steam of quality 0.97—that is, carrying 3 per cent. of moisture—would lower the capacity 6 per cent. and increase the water supplied to the boiler per horsepower-hour a like amount; for the water supplied but not evaporated is not only practically useless, but is a drag upon the turbine. The maximum horsepower is practically proportional to the absolute pressure, so that it may be easily computed for pressures other than the 125 lb. for which the diagrams are plotted. This water rate would be lowered about 1 per cent. for each 10 lb. additional pressure, and for every 10 deg. of superheat.

A government test of a 36-in. E5 turbine developing 125 hp. noncondensing gave the following results: 1260 r.p.m., 51.5 lb. steam per b.hp., 125 lb. gage pressure, 2 per cent. moisture.

An acceptance test of a 25-hp. generator unit, 2500 r.p.m., 72.6 lb. steam per kw.-hr., 47.6 b.hp., 88 per cent. generator efficiency, 97.5 lb. gage pressure atmospheric exhaust. It was guaranteed not to exceed 50 lb. per brake horsepower.

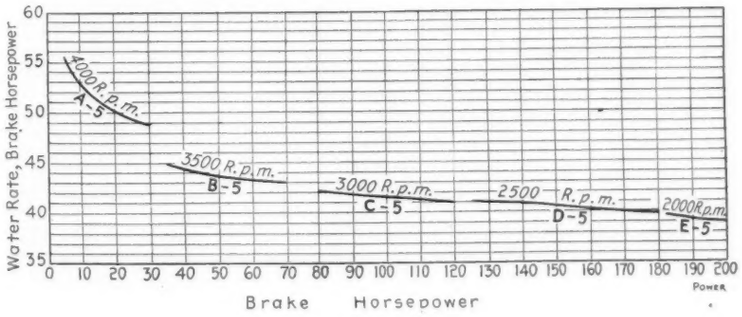


FIG. 11

A 24,000 Horsepower Turbine

From the Schlesischen Elektrizitäts- und Gas-Aktien-Gesellschaft, of Gleiwitz, the present proprietor of the Oberschlesischen Elektrizitätswerke, established in 1896 by the Allgemeine Elektricitäts Gesellschaft, the latter company has ordered for the central station at Chorzow a turbo-generator having a sustained capacity of 16,000 kw., with a power factor of 0.8. With an overall efficiency of about 90 per cent., this would call for the development of 24,000 hp. by the turbine.

The generator is of the well known A. G. E. type, designed to generate current at from 6000 to 6450 volts, and 50 frequency, when running at 1000 r.p.m. Steam of from 12.5 to 13 atmospheres (upward of 200 lb. gage) pressure and superheated to 300 or 350 deg. C. (572 to 662 F.) is to be used. This is a superheat of 188 to 278 deg. F.

In view of the fact that the condensing water is supplied from a cooling tower and deposits a hard scale, the generous amount of 400 sq.m. (4305.6 sq.ft.) of cooling surface has been provided in the condensers, of which there are two of 2000 sq.m. surface each, in order that the turbine may be run, with perhaps a somewhat impaired vacuum, with one condenser while the other is being cleaned. The heating surface consists of 3670 tubes, each about 20 ft. in length, and amounts to 2.69 sq.ft. per kilowatt, or 1.37 sq.ft. per horsepower. Greater accessibility for the expectedly frequent cleaning has been gained by placing the condensers in an annex to the turbine room and upon the same floor level.

Provision is made for handling 4500 cu.m. (about 159,000 cu.ft.) of cooling water per hour. This is something over 400 lb. per horsepower-hour. The pumps are divided into two units, each driven by a direct-connected electric motor, but a steam turbine is installed between them in such way that either or both may be driven by it in case a short-circuit should disable the motor.

The *Zeitschrift für das gesamte Turbinenwesen*, from which our information is derived, does not give any particulars as to the guaranteed or expected efficiency, but says that turbines of nearly as great capacity are being built for the central station at Oberspree, the Berliner Elektrizitäts-Werke and for the Zentrale Reisholz des Rheinisch-Westfälischen Elektrizitätswerke at Essen.

Some Boulton and Watt Letters

By S. W. Chubb

Extracts from a collection of letters at the Watt museum at the Tangye Works, Soho, Birmingham, throwing light upon early British steam engineering practice.

The writer, in an article which appeared in the June 21, 1910, issue of POWER, gave an account of a few of the relics of early British steam-engineering practice, etc., which have been stored by George Tangye in the Watt Museum, a special room forming part of the Tangye Works at Soho, Birmingham. Among the miscellaneous items of this collection may be noted a number of letters bearing various dates, written by Boulton, Watt and their London and Cornish agents, all of particular interest to the engineer, although not necessarily from the purely technical standpoint.

EARLY WORK

As a preliminary, one or two reminders, chiefly as regards dates, may be advisable. In 1765, Watt invented the separate condenser and air pump, turned the atmospheric engine into a steam engine and used the steam jacket. A patent was taken out in connection with these matters in 1769 and it was Roebuck's rights in this patent that Boulton afterward acquired. The patent was specially extended to 1800, and in 1776 expansive working was employed at Soho. In 1781, Watt's second patent, relating to the sun and planet motion, etc., was taken out, to be followed by the third patent in 1782 on the double-acting engine. Then, during 1784 Watt worked out the parallel motion, which was first put into practice in 1785. Probably this will be sufficient to elucidate the matters that follow.

FLYWHEEL CALCULATION

Boulton's method of calculating flywheels, if a little out of date, may yet afford some interest. It is shown in a letter to James Watt at Truro and dated Soho, Sunday, Jan. 13, 1781. After discussing the sun and planet gear and suggesting that "it is a desirable thing to have the pull of the engine as near the bearing part of the neck of the gudgeon or axis as possible," and showing how he would arrange for this, Boulton continues:

In all Rotative Motions derived from the Reciprocating ones, the Fly must be the equalizer. But let me see if I understand how to calculate ye effect of a fly of any given wt.

1st, I will suppose a stout man will raise 1 hogd of water, alias 600 lb, ten feet high in one Min't or 600 pounds one foot high per Mt. wch ÷ by 60″ = 100 lb one ft high per second. Thus 16 Men will raise 100 lb to the height of 16 feet per ″ from w'ch height it will fall in one second & will have acquired at ye end of its fall a Velocity of 32 feet. Hence 100 lb in ye rim of a Fly moveing with a velocity of 32 feet per ″ would require the force of 16 Men to stop it in a second but I will suppose ye wt. in our fly to move only 16 ft per ″ & in that case will require only 8 Men to stop it.

Hence a fly of one Ton say 2000 w'd require 8 × 20 = 160 Men, but as a Fly ought to have a sufficient Momentum to prevent the smallest degree of retardation from being perceived, I therefore suppose that where a Mill is required = in power to 160 men that the fly should be 400 lb at least.

When you want to amuse yourself with these subjects do tell me if I am right in my above reasoning — I am aware ye Engine acts ⅓ of ye time.

A BUSINESS LETTER

The following letter, dated Birmingham, June 18, 1781, addressed by the James Watt Co. to James Woodmason, London, is merely an example of a business letter. The Woodmason firm, of course, were agents for the sale of copying machines:

Birmingham June 18. 1781

To Mr. James Woodmason,
London.

Sir,

We have received your favour of the 13th and are sorry to find that the terms we proposed to you are not agreeable. Your being responsible for the payment was the principal ground of our offer of the 4 per cent on retail & 2% on Wholesale. You must remember that when you first applied for an allowance, when Mefsrs Boulton & Keir were in your Shop about three Months ago, and when you was asked what allowance would be satisfactory, you mentioned —— on all sold retail, and that you would be answerable for the payment of all the machines so sold, and that as to those sold in wholesale, you would not expect any thing for your trouble, but you did not say nor intimate that you would be responsible for the payment of these latter. When we had considered your proposal, we thought as you were well acquainted with the Merchants to whom you had sold machines in wholesale, that it might have been agreeable to you to take their debts also upon yourself for an allowance of 2½ per cent. But since we find our proposal is not agreeable, we shall accede to what you made to us about three months ago, namely, to allow you 5 per cent on all machines that have been sold in retail, upon condition of your being responsible for the payment of all that have been so sold. And we request that you will accordingly draw out your account to this time in that manner, that we may know what ballance to draw for, as we are much in want of cash, and that we may collect any of the wholesale debts that may be due, which will be a very troublesome affair to us to do. To this mode of settling the account of what is past, we agree, but as Mr. Watt came from Cornwall the day before your last letter arrived, we shall say nothing of any future plan, till we have had time to consult him. Only we request that if any applications be made to you for machines in wholesale, that you will please to consult us, or refer them to us, & we should at the same time be obliged to you for your opinion of the persons applying.

We are
Sir
Your obdt. Serv'ts
James Watt & Comp'y

STEAM CORN MILL

A letter addressed to Watt by Boulton from Soho on Jan. 18, 1782, and quoted below shows that the idea of a steam corn-mill was in the minds of the firm some time before the celebrated Albion mill, at Southwark in South London, had been started. This engine, which was double-acting, of course, was the first rotating engine with parallel motion erected in London. The scheme had been opposed because it was claimed that steam would throw wind and water-mills out of work, take away employment from the laboring classes, and, most extraordinary of all, reduce the price of bread. From the arguments used against him, Boulton easily deduced that all grinding should be done by hand. The letter also illustrates Boulton's method of calculating the sun and planet motion. It was as follows:

A person is coming from Liverpool Expressly to treat about a Steam Corn Mill & I think we must consent to erect one somewhere before long that we may know how to act in our business & to give answers. I think ye revolving wheel would make a good Corn Mill as you gain Velocity in ye 1st instance. I observe that what ever number of teeth there is in the Spear Wheel, The Central Wheel will make one revolution + that number of teeth. You desire that I would try two of ye little Engines with 2 of the rotative motions in order to see which looses the least power. Pray how did you think of applying the power? — did you mean to erect 2 pumps of = sizes or what. When you have done with drawings you sent of Rotative Motions & wch I returned to you I should be glad to receive any you can spare. I see a great field in Mill work open to us & I shall make a point of becoming an accurate Mill wright. We have no news here; very Stormy weather & a great Snow, all nature seems torpid

God preserve you and yours
M B

A postscript adds:

In some cases where you want to gain Velocity in the 1st Wheel you may make ye Spear wheel twice ye diamtr of ye Central Wheel by wch means it will make 3 rev'tns for each stroke of ye Engine. I think in general the wheels should be of as large a diamtr as convenient & also that the Mill end of en-

gine Beam should be longer than ye Engine End by wch you ballance ye piston & you get wheels of a larger Diamtr.

Murdock and Symington

The next letter, also to Watt, sent from Truro under date of Sept. 2, 1786, introduces the name of William Murdock, the man whose inventive ability has not altogether received a fair measure of appreciation—the sun and planet gear being still ascribed to Watt. It will be seen that Boulton met Murdock on his way to London for the purpose of taking out a patent for his steam car. The Simmington referred to is W. Symington, who was developing road locomotion as early as 1784, although certain of his proposals had been anticipated by Evans in America.

In or about 1786, Symington showed a steam carriage at Edinburgh, but, it is said, was deterred by the state of the Scottish roads from proceeding and transferred his attention to the use of the steam engine for marine purposes. The small three-wheeled locomotive which Murdock made was actually exhibited at a meeting of the English Institution of Mechanical Engineers, held at Birmingham in 1850. On this occasion, W. Buckle, formerly of the Soho works, read a paper on the inventions of Murdock and, describing the noncondensing steam locomotive, stated that the engine was constructed according to Watt's specifications of 1769.

The copper boiler had an oblique flue through it and a spirit lamp was used for heating purposes. The vertical cylinder was ¾ in. in diameter and had a 2-in. stroke; it was placed on top of the boiler and was connected to a single-arm vibrating beam which, by means of a connecting-rod, actuated a crank on the driving wheel. A double cylindrical slide valve was used, actuated somewhat roughly by means of the beam which in its motion struck shoulders on the valve spindle. The steam was exhausted from the center of the valve.

It will be seen that Boulton was quite aware of the value of Murdock's services and of his possibilities even at the date mentioned. He says:

I arrived at Exeter on Wednesday night and set out from there on Thursday afternoon to sleep at Oakhampton — about 1 mile on this side of Exeter. I met 3 of the Foxes going to a general Quakers meeting at Gloscester and in the same coach was Wm. Murdock. He got out and we had a parley for some time. He said he was going to London to get men, but I soon found he was going there with his steam car to shew it and to take out a patent. He having been told by Mr. Wm. Wilkinson what Sadler had said and he had likewise read in the newspaper Simmington's puff which had rekindled all Wm's fire and impatience to make steam carriages. However I prevailed upon him readily to return to Cornwall by the next days dilligence and he accordingly arived here this day at noon since which he hath unpacked his car and made travel a mile or two in River's great room in a circle making it carry the fire shovel poker and tongs. I think it fortunate that I met him as I am perswaded I can either cure him of the disorder or turn the evel to good at least; I shall prevent a mischief that would have been a consequence of his journey to London.

Murdock's Compressed-air Pump

A letter written from Chasewater, on Mar. 5, 1788, by Thomas Wilson, Cornish agent of the firm, shows what is perhaps not well known, that Murdock had devised a compressed-air pump. The account does not call for any explanation and is confirmed in a second letter in the same hand twelve days later, in which Wilson states that Murdock promises to write to Mr. Watt, "if it does well," anticipating great savings in erecting new engines, in rods, working pieces, buckets and gear "and fifty other things I can fancy both in erection and working."

Murdock's interest in compressed air continued, for in 1802 he used it in connection with the blast engine at Soho to blow cupolas, for driving a lathe, etc., and also for a lift. According to Buckle he had a piston working in a water cylinder 10 ft. in diameter with a lift of 12 ft.; the water being raised by forcing in air from a small blowing cylinder 12 in. in diameter with an 18-in. stroke, which was worked by gearing on the boring mill. He also employed compressed air for the bell system in his own house at Handsworth, a system which Sir Walter Scott copied for Abbotsford. Particulars can be found in the Buckle paper previously mentioned.

Chasewater March 5th 1788

D'r Sir

Enclosed is the acc'ts of Engines &ce for last Month. It was not untill the 28th upon sending to Consol'd Mines to settle the acct's that I found the people at the Mine had ommitted charging your savings in Jan'y; it appears since that this was not done by any order from Mr. Daniell, but as they were not charged in Decr. they took it for granted the ommission was to be continued. I shall mention this to Mr. Daniell tomorrow who I believe is ignorant of it, but am afraid it will be difficult to get it charged next acct. as the Loss will be 10 or £1200. The last Mo was near £800. I went yesterday to see Wm Murdock, he is better, but is still very poorly, he apprehended a Consumption, but I fancy it has been only a Very bad Cold, which is now loosened & is going of. He let me see his new method of raising Water; it is by Compressing Air at the surface which is forced down small pipes, to the Bottom of the Shaft & there communicates with the main pumps & forces up the water. What Machinery he has at the Bottom I cannot tell, only there is no Bucket, but there is a Clack to prevent the water falling Back. His present Machinery, is a Copper Tube of 1 inch Diamr. & 9 Inches Long, in this he works a Wooden Plug; from the side is a Very small Tube, which goes from the Top of his House to his Well 40 feet, & another larger Tube by the side up which the water ascends & runs of continually in an equal Stream. You know I am a terrible poor hand at Mechanics, & therefore will not venture an Opinion; but I think at any rate there should be a patent got for it. He proposes writing to you on the Business. He says Pipes of 3 Inches Diameter will do for forcing down the Air, to work 17 Inch pumps. If so there must be a great saving in erections for deep Mines. He has a very small string which goes down to the Bottom, which he pulls when he sets to work, I suppose to open a Valve. D. Watson has seen it & I believe we are the only people. He says that he does not doubt his Brother being able to put any Engine together & that he will have no objection to agree with you for (3) Years.

I am D'r Sir
Y'r Very H'ble Se't
Thos Wilson

London's 76,000 Tons of Soot

According to an investigation by the London *Lancet*, a medical paper, more than 76,000 tons of soot fell in that city last year. This vast quantity, all of which emanated from chimneys, contained over 6000 tons of ammonia, about 8000 tons of sulphates and 3000 tons of chlorine in chlorides, to say nothing of the carbon and tar.

It is further contended by this paper that the London rainfall in foggy weather is also distinctly destructive to metal surfaces, such as steel stacks, roofs, etc., inasmuch as decided traces of tin and lead were found in the specimens examined.

The heavy soot fall has been attributed to faulty combustion in coal fires. While the contamination of the air is mainly due to factories and power plants in the industrial centers, the fires in dwelling houses, especially in winter, have largely contributed to this serious nuisance.

Utilizing Sudd as Fuel

Sudd, an impenetrable mass of vegetation which obstructs the White Nile River in the Sudan, can be readily converted into fuel by a briquetting process, says the *Scientific American.*

The Sudan government has granted a 10-year monopoly for the manufacture of solid fuel from the sudd, and the concessionaires will have the exclusive right to cut sudd over an area of 93 miles, and 25 acres of land along the banks of the river have been granted on which to erect a factory. The government stipulates that its needs shall have the preference and prescribes a minimum output of 25,000 tons per year. The concessionaires say they expect that 50,000 tons will be produced.

It is Thomas A. Edison's opinion that storage-battery locomotives in Chicago's large terminal yards would do much to abate that city's smoke nuisance.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Catechism of Electricity

Construction and Operation of Carbon Arc Lamps

1209. *How many kinds of arc lamps are there?*

Four general types, namely: constant-potential lamps for operation in parallel on direct-current circuits; constant-potential lamps for parallel operation on alternating-current circuits; constant-current lamps for series connection on direct-current circuits; constant-current lamps for series connection on alternating-current circuits. The only essential differences between these four types are in the construction and operation of the mechanism.

1210. *For what purpose is mechanism needed?*

To control the relative positions of the two carbons.

1211. *How does the mechanism control the positions of the carbons and why is this necessary?*

The carbons must first be in contact with each other, to allow the current to flow through the lamp; then they must be separated slightly to form the arc between their ends. As the ends waste away, the gap between them must be adjusted so as to keep the length of the arc about the same throughout the burning period. The mechanism performs these two operations of "striking" the arc when the lamp is first put into the circuit and regulating the length of the arc during its activity.

1212. *How far apart should the carbons be separated?*

For currents up to 5½ amperes, which is the usual limit of constant-potential inclosed-arc lamps, the separation should be from $\frac{3}{32}$ to $\frac{3}{16}$ of an inch. For 6 to 7½ amperes, usual with constant-current inclosed arcs, the separation is from ⅛ to ¼ of an inch.

1213. *Explain the operation of the constant-potential direct-current arc lamp.*

Referring to Fig. 402, which is a diagrammatic view of a lamp of this type, *M* and *M* represent the two coils of a plunger-type magnet which is provided with a U-shaped armature *A*, consisting of two plungers joined by a yoke. The coils are connected in series with each other and with the brass tube *B* containing the upper carbon; therefore, the current entering the lamp at *P* passes through the magnet coils *M* to the tube *B*, thence down through the carbons and the wire *n* to a sliding contact *F* on the resistance coil *R*, and out at the binding post *N*. When current is first turned on, the magnet coils lift the armature *A*, which slides on the tube *B*. The upward movement of the armature causes a clutch *C*, which is linked to it, to raise the upper carbon rod and "strike" the arc. As the upper carbon is lifted away from the lower one the arc lengthens and its resistance therefore increases

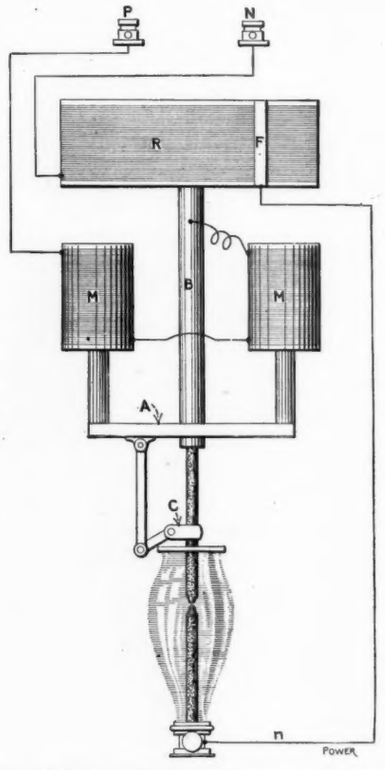


Fig. 402. Diagram of Constant-potential Direct-current Lamp

and the current decreases, weakening the magnets, until a point is reached where the weight of the armature and the carbon is just equal to the upward magnetic pull on the armature. As the lamp continues to burn, the carbons become shorter, thereby increasing the length of the arc and reducing the current, which weakens the magnetic pull on the armature; the latter therefore drops until the resistance of the arc becomes normal, when the magnetic pull again balances the weight of the moving parts.

1214. *Does the armature drop suddenly in adjusting the arc?*

No; the "feeding," as it is called, is made very gradual by attaching a dashpot to the armature, and thereby preventing any sudden movement or see-sawing.

1215. *Show the actual arrangement of the parts of the constant-potential direct-current arc lamp illustrated diagrammatically in Fig.* 402.

Fig. 403 is a picture of this mechanism. The magnet coils are shown at *M* and *M;* they are wound on brass spools which are attached to the central tube *B*. The resistance coil is shown at *R* and the sliding contact at *F*.

1216. *What is the reason for using the resistance coil and sliding contact?*

To take up the excess voltage of the circuit, to steady the arc and to provide means for adjusting the voltage at the arc. The sliding contact *F* cuts more or less of the resistance coil into the circuit; the more of the coil there is cut

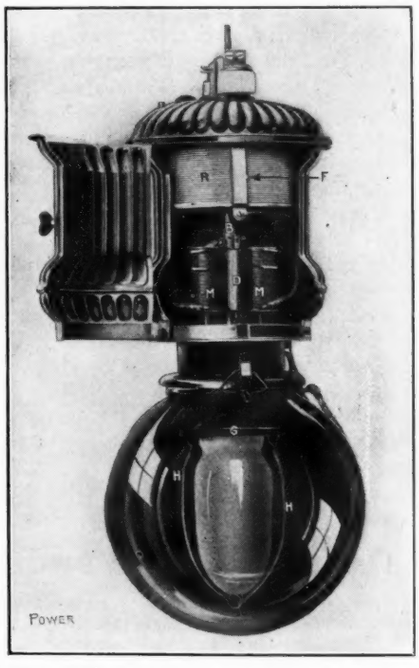


Fig. 403. Constant-potential Direct-Current Arc Lamp

in, the less will be the voltage at the arc, because of the increased drop in the coil.

1217. *Why is it necessary to adjust the voltage at the arc?*

Because constant-potential circuits are not all of exactly the same voltage, even when rated the same. The actual voltage of a so-called 110-volt circuit may be anywhere from 105 to 115 volts, or even 120. As the arc requires only about

75 volts, some extra resistance is necessary anyhow, and by making this adjustable, the voltage at the arc can be made normal no matter what the actual circuit voltage may be.

1218. *How does the resistance coil steady the arc?*

By the increase in the voltage drop in it when the current through it increases. An increase in the current flowing through the arc would decrease the resistance of the arc because the larger current increases the cross-section of the arc and also decreases the resistance of the carbon particles in the arc. A decrease in the current flowing through the arc, therefore, would increase the resistance of the arc. Consequently, if the supplied voltage was just equal to that required by the arc, and the arc resistance should be increased by the burning away of the carbons, the current would decrease, causing a further increased resistance of the arc, and this would cause a further decrease of current and increase of resistance, with the ultimate result that the arc would be

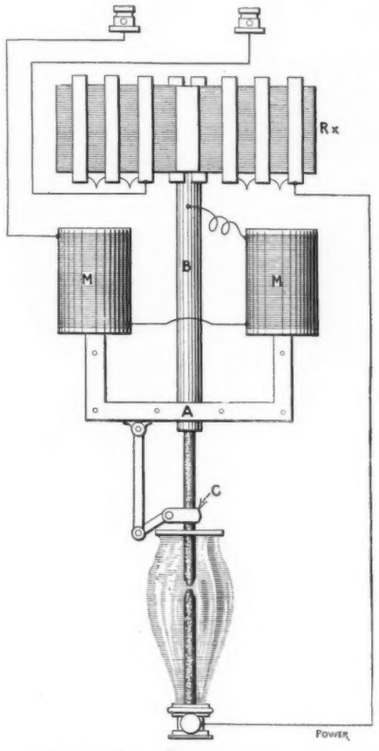


FIG. 404. DIAGRAM OF CONSTANT-POTENTIAL ALTERNATING-CURRENT ARC LAMP

broken. Likewise, an increase of current causing a decrease in arc resistance would still further increase the current and result in a similar unstable condition.

With the wire resistance in series with the arc and properly adjusted so as to make the arc voltage correct when the normal current is flowing through the lamp, a decrease in the current will diminish the drop through the resistance and, as the line voltage remains constant, the voltage across the arc will increase and compensate for the increase in resistance of the arc. Likewise, an increase of current causing a larger drop through the resistance will lower the voltage across the arc and maintain equilibrium.

1219. *Describe the other important parts of the arc lamp in Fig.* 403.

The dashpot *D* is attached to the armature of the regulating magnet for the purpose described already. The upper end of the top carbon is set in a metal socket which is electrically connected to the central tube *B* by a flexible stranded

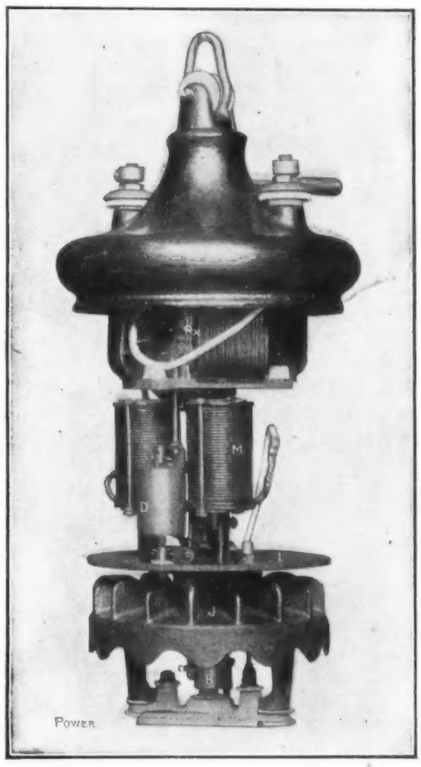


FIG. 405. MECHANISM OF CONSTANT-POTENTIAL ALTERATING-CURRENT LAMP

wire. The inner globe is of clear glass for outdoor service, and semi-transparent so as to diffuse the light for indoor service. It is supported by a spring bail *H* suspended from the cap *G* of the inner globe. An upward projection formed by a few turns of the wire of which the bail is made, rests in a depression in the lower end of the globe and exerts a steady upward pressure which keeps the upper edge of the globe at all points in close contact with the cap *G*.

1220. *Is a constant-potential arc lamp for alternating current exactly like the direct-current lamp?*

Not quite. The alternating-current lamp is provided with a magnet armature made up of thin sheets of soft steel riveted together, instead of solid plungers fastened to a solid yoke; also with a "choke" coil instead of the simple resistance coil of the direct-current lamp. Fig. 404 is a diagram of the parts, in which the "choke" coil R_x is substituted for the resistance coil *R* in Fig. 402 and the laminated armature *A* is shown.

1221. *Why is a "choke" coil used instead of a resistance coil?*

Because it wastes much less energy. A "choke" coil is a coil wound around a soft iron core which forms a closed

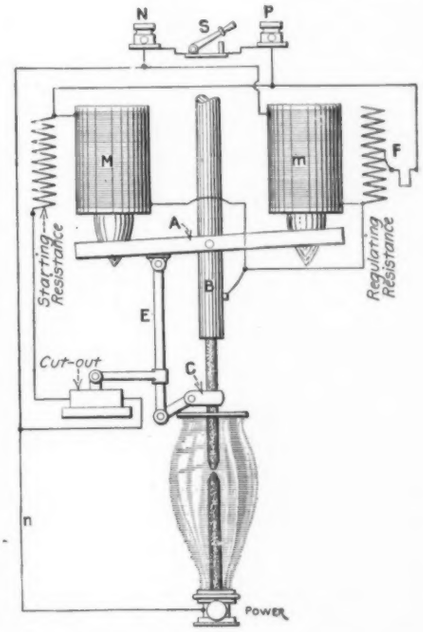


FIG. 406. DIAGRAM OF CONSTANT-CURRENT SERIES ARC LAMP

magnetic circuit. An alternating current passing through this coil produces a rapidly alternating magnetism in its core which induces a counter-electromotive force in the coil. This counter e.m.f. serves the same purpose as the drop in the resistance coil used in the direct-current lamp, but does not absorb any energy. There is some energy loss due to the resistance of the coil but it is very small because the resistance is extremely small.

1222. *If the choke coil wastes less energy than a resistance coil, why is it not used in the direct-current lamp?*

Because direct current flowing through it cannot produce the alternating magnetism in its core necessary to induce a counter e.m.f. in the coil.

1223. *Illustrate a constant-potential alternating-current arc lamp.*

The mechanism of such a lamp is shown in Fig. 405. The general outside appearance is similar to that of the direct-current lamp, Fig. 403. The entire lamp is built around the central brass tube *B*. The top or hood of the case is attached to the upper end and the floor plate *I* and radiating plate *J* to the lower end of the tube. The choke coil is shown

at R_x; the other parts are lettered the same as in Fig. 403.

1224. *What is the radiating plate for?*

To radiate the heat developed by the arc and thereby protect the magnets and mechanism from it.

1225. *How is the mechanism of the constant-current series lamp arranged?*

A diagram of the mechanism and circuits of this type of lamp for direct current is shown in Fig. 406. Two separate magnets are used, one connected in series with the arc and another connected in shunt to the arc. The series magnet is shown at *M* and the shunt magnet at *m*. The armature *A* in this lamp is pivoted to the central tube *B* instead of sliding on it, and it is tilted one way by the series magnet, to lift the clutch *C* and the upper carbon, and pulled the other way by the shunt magnet to release the clutch and drop the carbon. The switch *S* is used to cut the lamp out of circuit by short-circuiting the terminals.

1226. *Explain the operation of the mechanism in detail.*

When the lamp is first put in circuit, the armature *A* is tilted to the position shown, by the weight of the clutch *C* and its linkage; the clutch is then open, allowing the upper carbon to rest on the lower one. The current passes from the positive terminal *P* to the series magnet *M*, the starting resistance and the regulating resistance and divides between the three, but most of it goes through the magnet and the carbons and the return wire *n*, because that path has the lowest resistance. The magnet *M* lifts the armature and clutch, and the latter engages the upper carbon and carries it upward, striking the arc between the two carbons. As soon as the link *E* starts upward, it opens the contacts of the cutout and that part of the current which at first was shunted through the starting resistance now passes through the carbons. As the upper carbon is lifted away from the lower one the lengthening of the arc increases the voltage across the carbons and this increases the strength of the magnet *m* which is connected in parallel with the carbons; when the arc is at normal length, the pull of the magnet *m* is sufficient to prevent the magnet *M* from lifting the carbon any farther. As the carbons burn away, the lengthening of the arc shunts more current through the magnet *m*, and the magnet *M* is correspondingly weakened; the armature is therefore tilted slightly the other way, lowering the clutch *C* to the point where it trips and feeds the upper carbon downward.

1227. *What is the starting resistance for?*

To prevent the cutout from putting a dead short-circuit across the lamp when it is closed by the extreme downward travel of the link *E*. Such a short-circuit would make it impossible for the lamp to restart its arc automatically when next cut into circuit.

1228. *What is the need for the cutout?*

To close the circuit around the lamp if the upper carbon should hang up or burn so short that it could not be fed downward any farther. In either case, the arc becomes excessively long and the magnet *m* pulls its end of the armature up so far that the cutout is closed and cuts the rest of the lamp mechanism out of circuit.

1229. *What is the regulating resistance for?*

To adjust the strength of the lifting magnet *M* and thereby regulate the length of arc necessary for the feed magnet *m* to overcome the lifting magnet and feed the carbon. The regulating resistance is in shunt to the series magnet coil and shunts more or less current out of it, according to the position of the sliding contact *F*.

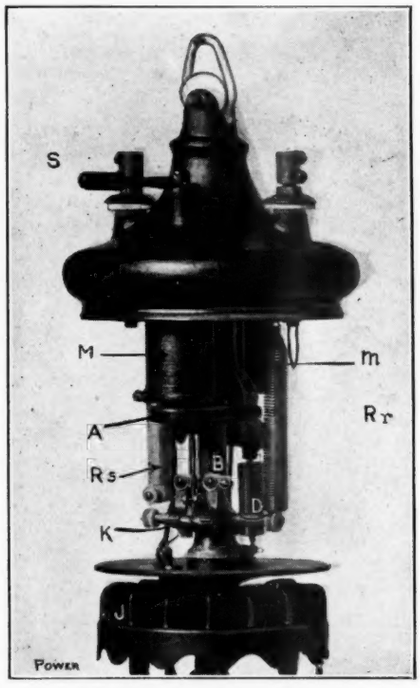


FIG. 407. MECHANISM OF CONSTANT-CURRENT SERIES ARC LAMP

1230. *Illustrate the actual mechanism of the constant-current arc lamp represented by the diagram.*

Fig. 407 shows the mechanism of this type of lamp. The cutout is shown at *K*, the starting resistance at R_s and the regulating resistance at R_r. The other parts are lettered the same as in Fig. 406.

1231. *Are all constant-current lamp mechanisms like the one just described?*

Not in all the details, but they all work on the differential principle; that is, a series magnet pulls the carbons apart and it is opposed by a magnet coil connected in shunt to the arc. In some lamps the shunt coil opposes the series coil magnetically instead of mechanically. Magnetic opposition is obtained by winding the series and shunt coils on the same core; any increase in the current in the shunt coil weakens the magnet as a whole, because the magnetizing effects of the two coils are in opposition to each other. In most cases, however, the magnets are separate and their pulling efforts are opposed mechanically, as in the lamp described.

1232. *Is the series alternating-current lamp like the direct-current lamp?*

Yes; in all essential features, except that the magnet cores and armatures are laminated instead of solid and choke coils are used instead of resistance coils, as explained in the discussion of constant-potential lamps.

LETTERS

Mr. McGinnitie's Rattling Exciter

I have had several cases of rattling such as Mr. McGinnitie described in the Jan. 2 issue, and in each case I found it due to the oil rings. The bearings being worn, the small pin which bridges the oil-ring slot to keep the ring in place would be found to be either broken off or bent up so that the ring had a chance to jump up and down on the shaft, due to the vibration permitted by the loose bearing. When the guide pin was replaced, keeping the ring down on the shaft, the rattle stopped.

L. M. JOHNSON.

Glenfield, Penn.

Mr. McGinnitie's exciter trouble reminds me of the case of a 25-hp. motor I once installed. It was used to drive a large fan and as first installed had a very poor foundation of timber and planks and the vibration was ascribed to that condition, but after being placed on a concrete foundation it did no better. Although it had been paid for, the manufacturer sent a man to investigate the trouble and remedy it if possible, but he did not succeed in locating it.

Finally, someone suggested that the shaft was not round. This was hardly taken seriously, but as everything else that anyone could think of had been tried, the shaft was taken out and measured with a micrometer; it was found to be 0.002 of an inch out of round. The maker was apprised of this fact and supplied us with a new shaft; after this was substituted for the old one, no further trouble was experienced.

This might possibly be the trouble with Mr. McGinnitie's machine; it would be worth while to caliper the shaft, at least, to see if it is dead round.

VICTOR JUMP.

Caledonia, Ohio.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

World's Production of Crude Petroleum

The world's production of crude petroleum for the five years from 1906 to 1910, inclusive, in barrels of 42 gal., by countries, was as follows:

Country	1906	1907	1908	1909	1910
United States	126,493,936	166,095,335	178,527,355	183,170,874	209,556,048
Russia	58,897,311	61,850,734	62,186,447	65,970,350	70,336,574
Galicia	5,467,967	8,455,841	12,612,295	14,932,799	12,673,688
Dutch East Indies	8,180,657	9,982,597	10,283,357	11,041,852	11,030,620
Roumania	6,378,184	8,118,207	8,252,157	9,327,278	9,722,958
India	4,015,803	4,344,162	5,047,038	6,676,517	3,137,890
Mexico	.....	1,000,000	3,481,410	2,488,742	3,332,807
Japan	1,710,768	2,010,639	2,070,145	1,689,563	1,930,661
Peru	536,294	756,226	1,011,180	1,316,118	1,330,105
Germany	578,610	756,631	1,009,278	1,018,837	1,032,522
Canada	569,753	788,872	527,987	420,755	315,895
Italy	53,577	59,875	50,966	42,388	42,388
Other countries (estimated)	30,000	30,000	30,000	30,000	30,000
Total	212,912,860	264,249,119	285,089,615	298,326,073	327,472,256

The production in 1910, as a simple arithmetical process will show, was, in round numbers, 13,753,835,000 gal., aggregating about 100,815,600,000 lb. This quantity would fill a pipe 50 in. in diameter extending entirely around the surface of the earth at the equator, and would maintain in continuous service, 24 hours per day, for a year Diesel-type engines delivering 23,017,000 hp.

The Cost of Oil Power

BY CHAS. H. HERTER

Referring to the discussion on the above subject in the issue for Jan. 2, the following explanation seems to be warranted in order to prevent the performance of the engine in question from being taken as representative of oil engines in general. The writer is familiar with the engine referred to, but is not interested commercially in any engine or power whatsoever.

The oil engine at New Haven is a Hornsby-Akroyd, of the type of English origin which has been on the market over 20 years. The compression is usually between 50 and 60 lb. per square inch, the maximum pressure after ignition 140 to 170 lb. and the mean effective pressure 40 to 45 lb. The exhaust valve is not water-cooled and the incoming air is heated by passing over it, thereby reducing the weight taken in. In the case of the New Haven engine the average brake horsepower is reported to have been 90, and so the fuel-oil consumption on the basis of oil weighing 7½ lb. per gallon figures up 1.59 lb. per brake horsepower-hour.

With a simple low-pressure engine of this type a fuel economy approaching that of a high-compression engine with adequate air supply and fuel injection at beginning of the power stroke cannot reasonably be expected, but even taking into account the load factor of $\frac{90}{125}$ or 0.72, the oil consumption should not have exceeded 1.1 lb. per brake horsepower-hour, the consumption at full load being guaranteed not to exceed 1 lb., and having been found in some sizes to be less than 0.9 lb. It is possible that too much heat was carried off by the jacket water. At light load the discharge temperature can safely be carried higher than at full load.

It will be clear from the foregoing that the oil engine at New Haven is not in the same class with the more modern high-compression De La Vergne and Diesel oil engines, the fuel consumption of which is but one-half of that of the type built years ago.

The overall efficiency of the plant in question could perhaps be improved by utilizing the waste heat by means of a water heater utilizing the heat of the exhaust gases and that usually lost in jacket water. About 3600 B.t.u. per brake horsepower-hour have been recovered at full load from the exhaust and 5000 B.t.u. from the jacket water of a natural-gas engine. To what extent the carbon carried in the exhaust would reduce the efficiency of the surface of such heater remains to be seen. In the Hornsby-Akroyd engine the heat radiated by the glowing vaporizer cannot be recovered, of course.

California's petroleum production in 1911 is estimated by David T. Day, of the United States Geological Survey, as reaching a possible 83,000,000 bbl. as compared with 73,010,560 bbl. in 1910. The increased production was chiefly from the Sunset and McKittrick region, from the pools already developed in 1910.

The Oil Power Vessel "Jutlandia"

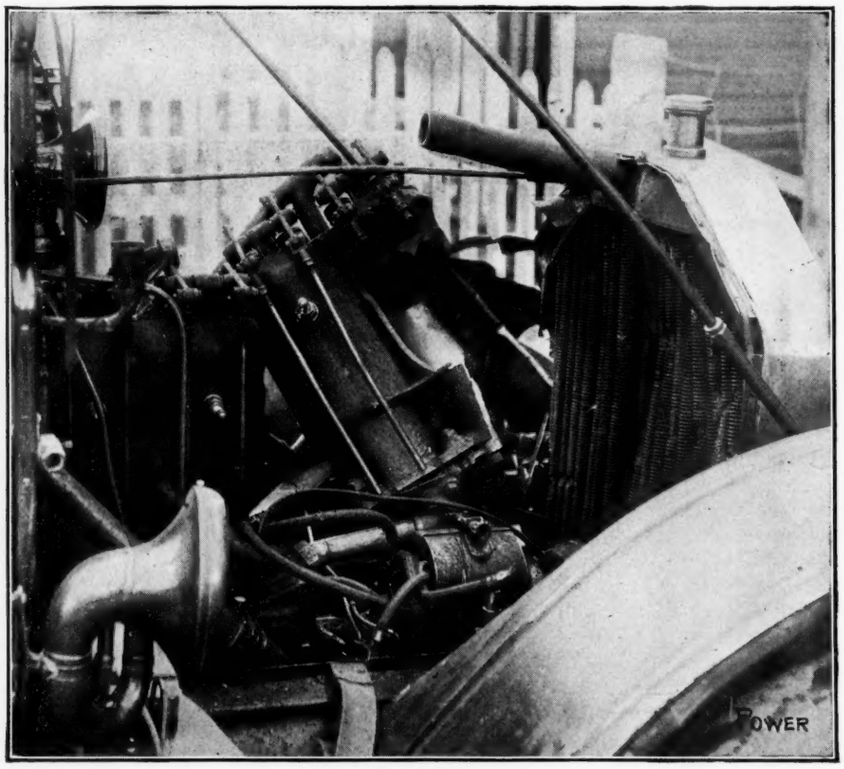
The twin-screw oil-engined vessel "Jutlandia," recently built by a British firm to the order of the East Asiatic Co., of Copenhagen, was launched on Dec. 11. Her dimensions are 384 ft. length, 53 ft. 3 in. breadth, 30 ft. depth. Her displacement is 10,000 tons at 23 ft. 6 in. draft, and the dead-weight capacity 7000 tons, with a registered gross tonnage of 5000. She will be supplied with two sets of Diesel oil engines capable of developing 3000 indicated horsepower. She will have three masts, and the exhaust gases from the engines will be led up inside the mizzen mast and exhausted at a height of 48 ft. above the deck, so that no separate stack will be needed. A noteworthy and economically very important feature is that the machinery space is only about a third of that which would have been necessary for steam engines and boilers, and that the absence altogether of boilers and boiler casings leaves a large amount of hold and 'tween-deck space for the storage of cargo and the accommodation of passengers. The siren, on the mainmast, will be operated by compressed air. It is expected that the "Jutlandia" will be ready for speed trials some time next month.—*Exchange.*

LETTERS

Two Gasoline Engine Wrecks

In the Jan. 9 issue, L. Earle Browne and R. E. Wall describe two gasoline-engine smash-ups. In Mr. Browne's case the first question which occurs to one is: Did the explosion take place above or below the piston? If it took place above the piston, that is to say, in the combustion chamber, it may have been due to the ignition of a very rich mixture while exactly on, or very nearly on, dead center. The last time the engine was stopped, the driver may have switched off but left his throttle wide open, which would allow the engine to take several inspirations of a rich mixture, the gasoline content of which would condense on the cylinder walls and piston head. On cranking over for starting up the next time—the time of the accident—the throttle would be fairly wide open and the mixture obtained therefrom, in addition to that already in the cylinder, may have been sufficiently explosive to cause the wreck. It will be observed that the engine had been cranked around twice, through a complete cycle.

If, however, the explosion took place in the combustion chamber, one would expect the pieces to have been blown more vertically than horizontally, as they apparently were. Also, it is hard to see why the bottom half of the crank case should have been blown into "a hundred or more pieces." I am inclined to think that the explosion took place in the crank case and that No. 1 and No. 4 pistons were descending at their maximum velocity at the time of the explosion, the tendency then being to destroy the crank case and to wreck No. 1 and No. 4 cylinders. No. 1, being the weakest, went in this case. The pieces would also be thrown in the manner described in this event.



MR. BROWNE'S AUTOMOBILE-ENGINE EXPLOSION

Then comes the query: How did the explosive mixture find its way into the crank case? The answer is simple. Many automobile owners are troubled by gasoline leaking past the pistons and mixing with the lubricant in the crank case, causing trouble by thinning the oil with which it becomes emulsified. Now the engine had, in this case, been standing for four days. This left ample time for the gasoline and the oil to separate out, the gasoline floating on the top by virtue of its lower specific gravity. Its presence being accounted for, next comes the question of how the mixture got ignited. As the engine had been standing for four days, the cylinder walls and internal mechanism generally had been drained comparatively dry of oil. Given one or two stuck or badly worn rings and an ignition in one of the cylinders, and it is possible that a tongue of flame may have found its way between the stuck rings and the dry cylinder wall and fired the mixture in the crank case. Alternately, the accidental striking of one metal part by another metal part inside the crank case may have caused a spark which ignited the explosive mixture.

With regard to Mr. Wall's smash, he says that when the engine got "fairly started" he turned the ignition timing to the running position. This sounds rather as if he shifted the timing lever from starting up to full-load position all at once. If so, an ignition on center, or early, may have caused the engine to give way along the line of least resistance as he suggests. Ignition timers should always be gradually moved on gasoline engines, and the engines should be more than "fairly started"—as I read it—before the spark is set to occur in advance of center.

JOHN S. LEESE.

Manchester, Eng.

On page 54 of the issue of Jan. 9, L. Earle Browne asks for opinions as to what caused the explosion of a gasoline engine. On looking at the photograph it will be noticed that the most damage was done beneath the explosion chamber, and Mr. Browne says that the crank case was broken into a hundred or more pieces and that both Nos. 1 and 2 cylinders were torn away from the bottom casing.

My theory is that in some way an explosive mixture got into the crank case and exploded there; this could be accounted for by there being a hole or flaw through the piston face. This mixture would have a tendency to fire from a spark at the spark plug in the combustion chamber. On the other hand, some one may have injected some gasoline into the crank case, thinking to play a joke on the operator and not realizing the possibility of serious consequences.

However, I am sure the explosion was caused by gas in the crank case as, if any of the parts, such as the connecting-rod or crankshaft had been bent, there would not have been so many broken parts. It would be well to thoroughly examine the piston and cylinder internally to find if there was any flaw showing where gas could escape into the crank case. If no flaw is found, it might be worth while to look over the electric connections thoroughly to find out how a spark got into the crank case.

G. H. HANDLEY.

Newburgh, N. Y.

I showed Mr. Browne's article to Mr. James H. Fennon, an expert on gas engines and a mechanical engineer of rare ability, and asked him to solve the problem. The engine was evidently a water-cooled machine, and in Montana at this time of the year the climate is more than cold; Mr. Fennon suggests that the water jackets froze with the intense cold and cracked the cylinder in a hundred places, and when the gasoline explosion occurred, it simply blew out these cracked pieces and wrecked the machine.

STEPHEN C. BROWN.

Natick, Mass.

Curing Hot Bearings

Several weeks ago on account of low water our station was called on to take our street-railway load. We have two 800-hp. gas engines and were doing some repair work on them; therefore we were not in good shape to run. However, we managed to get both engines going, but in about 30 minutes the left-hand main bearing on No. 2 engine was smoking hot. We had a very big load and could not shut down without overloading the other engine. After trying every kind of "dope" I could think of, without any improvement, I slowed the engine down as slow as it would run and tightened the quarter boxes a little at a time until they were jam up, keeping them well flooded with cylinder oil and a little flake graphite. I let it run that way for a few minutes and then began to loosen up a little on the boxes. After it cooled down to a running temperature, I gave the engine the load again and that was the end of that box getting hot.

J. B. LINKER.

Charlotte, N. C.

Refrigeration Department

Principles and operation of ice-making and refrigerating plant and machinery

Cold Storage of Furs and Fabrics

By E. F. Tweedy

The placing of furs and such fabrics as carpets, tapestries, clothing, woolens, etc., in cold storage to protect them against insects during certain portions of the year, is now generally recognized as the most satisfactory method of dealing with this important problem. The annual loss arising from the destruction of the above classes of merchandise by the moth and the beetle cannot be even approximately estimated, but the yearly toll is unquestionably tremendous, and any means of reducing this loss is therefore worthy of serious consideration.

The first storage warehouse in this country to undertake the cold storage of furs, carpets and other fabrics was apparently that of the American Security & Trust Co., of Washington, D. C., which provided cold-storage facilities for goods in 1894.

For two years thereafter, the manager of the cold-storage department of this company, Albert M. Read, assisted by Dr. L. O. Howard, chief of the bureau of entomology of the United States Department of Agriculture, carried on a series of extremely interesting and valuable tests to determine the effects of various temperatures upon the larvæ of the moth and beetle. These were probably the first tests ever conducted along similar lines, and the results secured served largely as a basis for the subsequent commercial development in the use of cold storage for the protection of furs and fabrics.

The cold storage of furs at first was opposed by many furriers, who had derived a considerable income from caring for their customers' furs during the summer months, such care usually involving a frequent brushing and shaking of the furs, separated by intervals during which they were packed away with camphor, tar paper or some other moth-repelling substance.

But such opposition gradually disappeared and today the leading furriers either operate their own cold-storage vaults or else rent storage space in cold-storage warehouses. The latter are rarely so located as to be conveniently reached by the furriers' patrons, and this is doubtless the reason the majority of the furriers and department stores maintain their own refrigerated rooms for storing furs.

In the experiments referred to it was found that any temperature below 45 deg. F. was sufficient to keep the larvæ of the moth and the beetle from doing any damage, although the larvæ were capable of sluggish movement at a temperature as low as 42 deg. F. Below 40 deg. all movement was suspended and the larvæ became entirely dormant, while above 45 deg. activity of the larvæ began and increased with each degree up to 55 deg. when a normal, active condition was reached.

It was found that the larval condition was the one in which the damage occurred, as the grease and animal juices in the fiber of the fur and wool serve as food for both the moth and the beetle larvæ while these insects are passing through this stage. The larvæ, it was found, could withstand as low as 18 deg. F. for a long period without harmful effects and they changed back from a dormant to an active condition when the temperature again became normal. However, if repeatedly exposed to considerable changes in temperature, the larval vitality was considerably reduced —a fact which should cause a winter composed of alternating periods of cold and mild weather to be followed by a summer of decreased insect life. Also that the miller and the beetle were soon killed when subjected to temperatures below 32 deg. F. and that they gradually died if exposed to between 32 and 40 deg. F.

While these investigations showed that cold-storage rooms for preservation of furs and fabrics may be kept at 40 deg. F. with perfect safety, the temperatures most commonly carried in cold-storage rooms today range from 20 to 26 deg. F. At these lower temperatures the furs retain a fresh and glossy appearance, and the flexibility of the skins is preserved by a lessening of the evaporation of their natural oils.

Two methods of applying mechanical refrigeration to the cold storage of furs and fabrics are in general use; one is the direct system and the other the indirect, each system possessing advantages as well as disadvantages. In the direct system the refrigerating coils—either arranged for direct expansion or for the circulation of brine—are placed within the storage room itself, being mounted upon the side walls or ceiling, or upon both. The indirect system comprises an air-cooling room or bunker space in which are the refrigerating coils, this space being entirely separate from the room to be refrigerated but connected with it by a system of ducts through which the refrigerated air is circulated by means of a fan.

The advantages of the direct system are that it is somewhat cheaper to install and also to operate: the first, because of the elimination of the air-cooling chamber and air-circulating fan, although this is partially offset by the somewhat greater cost of the piping for the cooling coils; the second, because it is unnecessary to operate an air-circulating fan, which requires an appreciable amount of energy. With either system, using brine as the cooling medium adds materially to the first cost of the installation, and likewise increases the cost of operation due to the necessity of constantly circulating the brine.

The use of brine arises from the fear of a leak in the ammonia piping, with a consequent damage to the goods in storage. Where the ammonia piping is carefully installed and tested before being placed in operation, danger from the leakage of ammonia gas is probably not great, as the successful operation of the large number of plants employing ammonia as the refrigerating agent bears witness.

However, in view of the heavy financial responsibility usually involved where furs in any quantity are held in storage, this question is of considerable importance, and where ammonia is employed as the refrigerating agent, the indirect system, with brine as the secondary cooling medium, offers the greatest amount of security against damage from the refrigerating medium itself. The indirect system is further advantageous in freeing the storage space of the moisture which collects as frost on the piping and which melts and drips from the pipes if the temperature rises above the freezing point. The air in the storage space is therefore drier where the indirect system is used; this is also an advantage, provided the percentage of moisture is not reduced too far, a condition which can easily be prevented.

One of the arguments advanced against the indirect system is that it involves an increased fire risk, as the movement of the air in the storage space might tend to fan a fire if one should occur. This belief was considerably strengthened by a fire, involving a heavy financial loss, which occurred in the fur cold-storage room of a large department

store in Brooklyn a few years ago. The origin of this fire was unknown, but it has been generally contended that the system of air circulation that was in use was responsible for the fire.

As a result, the New York Fire Insurance Exchange made certain recommendations as to the manner in which the indirect system of refrigeration for fur-storage rooms should be installed. These recommendations call for the air duct or ducts to be equipped with automatic dampers, arranged to be controlled by fusible links properly installed; the blower or fan to be equipped with an automatic controller arranged to be operated either by electric thermostats having a low fusing point, or by thermometers having proper attachments installed within the cold-storage room, and that these devices be adjusted to operate the controller on the blower so that when the temperature rises to 100 deg. F. the blower will shut down. Where these recommendations are observed, this system apparently offers no material increase in fire risk over the direct system.

TABLE 1. CHARACTER OF INSULATION

	B.t.u. per sq.ft. per 24 hr. per deg. dif. between outside and inside temp.
Double ⅞-in. boards and paper, 1-in. air space, 5-in. sheet cork, paper and ⅞-in. board	0.90
Double ⅞-in. boards and paper, 1-in. air space, 4-in. sheet cork, paper and ⅞-in. board	1.20
Two ⅞-in. boards and paper, 8-in. mill shavings, two ⅞-in. boards and paper	1.35
Same slightly moist	1.80
Same damp	2.10
Double ⅞-in. boards and paper, 4-in. granulated cork, double ⅞-in. boards and paper	1.70
One ⅞-in. board and paper, 3-in. sheet cork, paper, one ⅞-in. board and paper	2.10
One ⅞-in. board, 6-in. patent silicated strawboard (air cell), finished with thin layer of patent cement	2.48
Four double ⅞-in. boards with paper between (eight boards in all) and three 8-in. air spaces	2.70
One ⅞-in. board, paper, 2-in. sheet cork, two ⅞-in. boards and paper	3.00
Two ⅞-in. board and paper, 1-in. sheet cork, two ⅞-in. boards and paper	3.30
Two ⅞-in. double boards and two papers, 1-in. hair felt between	3.32
One ⅞-in. board and paper, 2½-in. mineral wool, paper and ⅞-in. board	3.62
Two ⅞-in. boards and paper, 1-in. air space, two ⅞-in. boards and paper	3.71
One ⅞-in. board, 2-in. pitch, one ⅞-in. board	4.25
One ⅞-in. board, 1-in. pitch, one ⅞-in. board	4.90

The refrigerating requirements for given outside temperature conditions, and for a given maintained temperature within the cold-storage space, are, of course, directly dependent upon the insulation provided for the floor, walls and ceiling of the room to be refrigerated. As the insulation in different installations varies greatly in its effectiveness in limiting the passage of heat from the outside to the inside of the refrigerated space, it is impossible to even approximately estimate the refrigerating requirements for a given volume of cold-storage space without a knowledge of the character of the insulation to be employed.

This is particularly evident when one considers that with some of the different combinations of insulating materials in ordinary commercial use variations may be obtained in heat transmission from less than 1 to nearly 5 B.t.u. per 24 hr. per square foot of exposed surface for each degree of difference between the inside and outside temperatures. Table 1 shows the approximate number of B.t.u. transmitted per square foot per 24 hr. for each degree of temperature difference for several different types of insulation commonly met with in practice.

The number of cubic feet of refrigerated space per ton of refrigeration naturally varies with the size of the space refrigerated, other conditions remaining the same, inasmuch as the exposed surface through which the gain of heat occurs does not increase in proportion to the increase in the volume of the refrigerated space. It is also somewhat affected by the system of refrigeration employed; that is, whether the direct or the indirect system and whether brine is used as a secondary cooling medium. As in all other refrigeration problems this question of insulation is of paramount importance, and the saving in the cost of power required will almost invariably pay a large return upon the money invested in a high grade of insulation.

TABLE 2. CAPACITY OF PLANT AND VOLUME OF REFRIGERATED SPACE

Capacity, Tons Refrigeration	Motor Driv. Refrig. Plant, Hp.	Contents Storage Space, Cu.Ft.	Cu.Ft. Storage Space per Ton Refrig.	Sq.Ft. Surface (Floor, Ceil., Side Walls) per Ton Refrig.	System
50	..	155,000	3,100	...	Indirect—brine coils
20	35	60,000	3,000	748	Indirect—ammonia coils
15	25	40,500	2,700	651	Indirect—ammonia coils
10	15	32,700	3,270	805	Direct—ammonia coils
4	7½	5,720	1,430	569	Direct—ammonia coils

Table 2 shows the capacity of the refrigerating plant installed, the cubical contents of the space refrigerated, the volume of refrigerated space and the total exposed surface per ton of refrigerating plant capacity, together with the system of refrigeration employed, for a number of electrically driven refrigerating plants used in connection with the cold storage of furs and fabrics.

Table 3 gives some figures on power required for motor-driven refrigerating plants used exclusively for the cold storage of furs. In cases 2 and 4, the compressor motors were not separately metered prior to June, so that the kilowatt-hour consumptions for the preceding months were not available. In cases 1 and 3, the consumption figures cover an entire year, although these plants were in actual operation only during some seven or eight months.

It is somewhat surprising to observe how low the load factor is in these plants, even during midsummer. Based on the rating of the motor which drives the compressor, plant 1 operated at rated load for only 10 per cent. of the time during July, the month of greatest consumption; while for the entire period (May to October, inclusive) it operated at its rated capacity only 6½ per cent. of the time.

Upon the same basis, plant 2 showed a 30 per cent. load factor for September, and a 27 per cent. load factor for the seven months ending with December. Plant 3 had a load factor of 16 per cent. during June, and a load factor of 12 per cent. for the period beginning with March and ending with October; while plant 4 had a maximum load factor of 21 per cent. during July, and 16 per cent. for the seven months ending with December. The load factor thus based upon the rated capacity is, of course, dependent upon the relation of the size of the plant to the actual refrigerating requirements.

While it is quite usual to provide refrigerating capacity sufficient to permit the plant being closed down during 12 or 14 hr. out of the 24, even at a time when the refrigerating requirements are at a maximum, it would appear that all of these plants, with the possible exception of No. 3, have capacities considerably in excess of those actually needed to meet present requirements.

It is somewhat difficult to accurately predict what the consumption of electrical energy will be for a proposed fur-storage plant unless there is detailed information as to the character of the insulation to be employed and unless the type of refrigerating plant that is to be installed is known. The method of operation will also affect the consumption materially, as, for instance, whether manual or thermostatic control of the compressor is employed. From an examination of the data given in Table 3, it would appear that the kilowatt-hours per square foot of exposed surface (including floor, ceiling and side walls) varies, for these particular plants, from a little under 1 to about 3, this variation being due not only to the character of the insulation employed but to the

type of plant and to the method of its operation.

The operation of plant 3, in Table 3, is briefly described as being typical of the modern fur-storage plant. It is operated about eight months of the year, usually from Mar. 1 to Nov. 1, but sometimes for a longer period, according to the weather conditions. The storage vaults contain about 60,000 cu.ft., and about 15,000 fur garments are stored during the summer months. The ammonia expansion pipes are located in a cooling room containing approximately 2700 cu.ft. A system of ducts connects this room with the cold-storage vaults, and the air is kept in circulation by means of a blower operated by a 4½-hp. motor.

Brine is allowed to trickle over the ammonia pipes to keep them free of frost, and its circulation is effected by means of a 1-hp. motor-driven centrifugal pump. This brine is not employed as a secondary cooling medium, as in the brine system proper, but simply for the purpose stated. In thus keeping the external surfaces of the cooling coils free from frost, the transfer of heat from the air of the cooling chamber to the expanding ammonia gas within the coils is facilitated and the operating efficiency is thereby increased.

During the winter months the plant is not operated as there are few furs in storage and the outside air is sufficiently low to maintain them in a satisfactory condition. During this period the blower circulates the outside air through the vaults, which are thus maintained at about 10 deg. above that of the outside air.

After the plant is started in the spring and until it is shut down in the fall, the temperature in the storage vaults is never allowed to rise above 32 deg. F. During this period the average temperature is approximately 20 deg. F., ranging from 26 deg. in the early morning to about 14 deg. just before the plant is closed down in the afternoon. From 6 p.m., when operation is ordinarily discontinued, until 8 the next morning, when it is usually started again, the rise in temperature is about 12 deg. On Monday mornings, the plant having been shut down over Sunday, the temperature is generally about 30 deg. F.

The storage vaults and the cooling room are well insulated. The floor insulation consists of 1 in. of paving cement, two 2-in. layers of cork, a layer of felt, 6 in. of ordinary cement and finally 3 ft. of slag cement. The ceiling comprises ½ in. of plaster, four 2-in. layers of cork, a 4-in. air space, and above this a layer of firebrick. The walls are composed of firebrick with cork insulation embedded in tar. From the actual kilowatt-hours consumed during the summer months, taken in connection with the recorded mean temperatures of the outside air during the same period, it would appear that the average loss through the floor, ceiling and walls of this vault is approximately 1.25 B.t.u. per square foot per 24 hr. per degree difference in temperature, which shows that a high quality of insulation has been provided.

TABLE 3. POWER REQUIRED BY COMPRESSORS OF VARIOUS CAPACITIES

Month	1 4-ton Comp., belt-driven, 7½-hp. motor; direct system; ammonia coils Consump., Kw.-hours (Comp. only)	2 10-ton Comp., chain-driven, 15-hp. motor; direct system; ammonia coils Consump., Kw.-hours (Comp. only)	3 20-ton Comp., belt-driven, 35-hp. motor; indirect system; ammonia coils Consump., Kw.-hours (Comp. only)	4 15-ton Comp., belt-driven, 25-hp. motor; indirect system; ammonia coils; thermo. control; 5 hp. motor drives fan for circ. air. Consump., Kw.-hours	
				Compressor	Fan
Jan.	....	.....	.....	.....	....
Feb.	....	.....	.....	.....	....
Mar.	....	.....	1,872	.....	....
Apr.	5	.....	3,056	.....	....
May	193	.....	3,344	.....	....
June	374	2,688	3,384	3,195	649
July	507	2,876	3,224	3,550	535
Aug.	396	2,708	3,264	3,390	513
Sept.	387	2,945	2,656	3,165	424
Oct.	68	2,693	936	2,594	363
Nov.	1	2,550	.....	1,490	204
Dec.	..	2,087	.....	585	81
Total.	1,931	18,547 (7 mos.)	21,736	17,970 (7 mos.)	2,769
Kw.-hours yer yr. per sq.ft. surface (comp. only)	0.85	2.3 (7 mos.)	1.45	1.84 (7 mos.)	

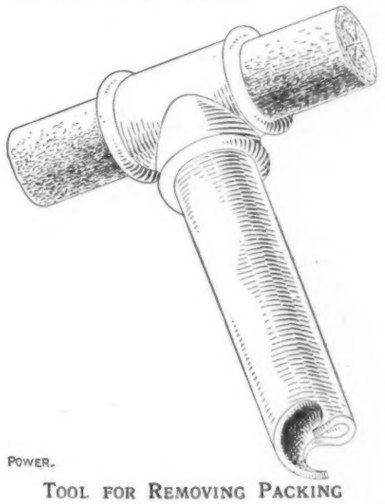
In New Zealand, boiler explosions are almost unheard of. Reference to the last annual report of the Inspection of Machinery Department discloses the remarkable record made in that country. "During the 21 years I have been in the department," says the chief inspector, "only two explosions have occurred. This is a very fine record for in that time over 10,000 boiler inspections have been made and boiler pressures have increased 50 per cent." This high efficiency is in marked contrast to the numerous explosions that yearly occur in the States.

LETTER

Removing Rubber Packing

Now is the time when refrigerating engineers should start their annual repairs and for this work the accompanying letter may be of some use. I have just removed the coils from a condenser and absorber of the shell type and found it slow work drawing the lead and rubber rings with regular packing tools from around the tails of the coils. The repairmen from the shops may have some tools for quick work, but I have never heard of them.

After several experiments with hooks and chisels, I started on a different plan which was very successful. Take a piece of pipe one size larger than the tail of the coil and, when not large enough to slip over the tail easily, split it on one side far enough to allow it to reach the bottom of the recess.



POWER.

TOOL FOR REMOVING PACKING

At one end of the pipe drill a ¼-in. hole clean through and with a hacksaw cut out the pipe, as shown in the drawing, leaving the end of the pipe with two projections very similar to the old "hook-tooth" saw. With the side of a tee on the other end and a short stick or pipe through the run of the tee as a handle, the tool is used as an auger.

In working the lower ends of the coils take off the tee and use a pipe wrench to turn the tool. Care should be used when cutting the lead at the top and the bottom of the recess that the tool does not "hog" in and bite off more than can be pulled out. When cutting the rubber the work is easier if the tool is lifted out occasionally to allow the chips to fall out of the holes. To remove the packing from sixteen 1¼-in. and four 1-in coils I estimated the time as three days. I made two tools, one of 1¼-in. pipe for the 1-in. coils and one of 1½-in. pipe, which I had to split for the 1¼-in. coils, and was through with the job on the second day.

W. C. REED.

Pittsfield, Mass.

LETTERS

Temperature of Ammonia Compressor Discharge

Referring to D. E. Aden's comments in the Dec. 12 issue, page 898, on T. L. D.'s questions on the above subject, I submit the following:

The temperature of the gas in the discharge pipe of an ammonia compressor is not directly related to the condenser pressure, but is more related to the back pressure and to the temperature of the suction gas at the compressor, as on these two (suction temperature and pressure) depend the quality (degree of wetness) and the quantity of gas to be compressed.

E. N. Friedmann, retiring president of the American Society of Refrigerating Engineers, submitted the following tentative figures, in a paper read before the St. Louis meeting of that society, in October, 1911:

Back pressure gage, lb. per sq.in.	Temperature of single-acting comp., deg. F.	Discharge gas, double-acting comp., deg. F.
5.0	260	300
15.0	240	287
25.0	213	253

The temperature of the suction gas is not given in the table, but Mr. Friedmann mentioned in the same paper that the suction-gas temperature should be close to the saturation temperature at the given pressure.

As to the dissociation of ammonia gas, authorities claim that it does not begin to dissociate until a temperature of 900 deg. F. is reached. This is far higher than any temperature existing in refrigerating machinery.

ALBERT J. GILL.

Washington, D. C.

Ammonia Packing Gives Trouble

In the plant where I am employed there is a 10 and 4 by 10-in. ammonia pump used in connection with an absorption refrigeration system. We have a good deal of trouble in keeping the ammonia end of the piston rod packed. The packing lasts but a short time, being eaten out, so to speak, making it necessary to pack the pump very frequently. Ordinary ammonia packing is used. It comes in both solid and diagonally split rings, and in packing the pump the rings are alternated. We tried taking the spool out and filling the entire box with packing; also, inserting rings of lead between the rings of packing, but with no success in either case.

If any of the readers of POWER have had like difficulties, I would like to know how they were remedied.

H. G. GIBSON.

Washington, D. C.

Nugent Oil Filter

The new oil filter recently gotten out by William W. Nugent & Co., 220 West Huron St., Chicago, Ill., is illustrated herewith.

Referring to Fig. 1, oil is poured into a tray *D*, or if the filter is connected to an oiling system, the water and oil is piped to *A*. In the bottom of this tray is an opening about which an inverted cone of reticulated material is placed. The heavy or coarse particles of grit are here removed and separated. The oil passes through the drips *F* into three funnel-shaped filtering bags *I*.

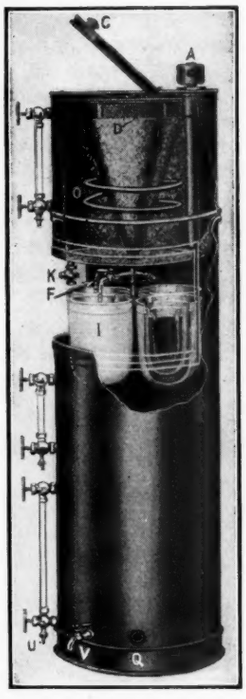


FIG. 1. NUGENT OIL FILTER

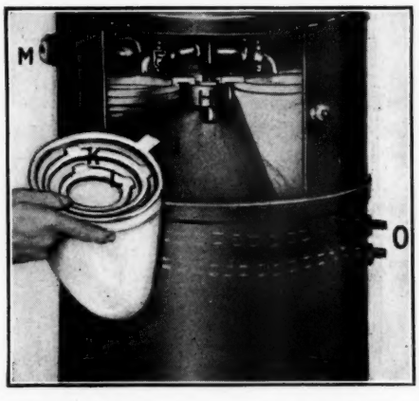


FIG. 2. REMOVING A FILTERING BAG

There are four sets of these bags and they are attached to three independent rings or holders to each set. Each ring with its respective bag may be removed for cleaning independent of each other. Each set of bags or rings is provided with a hook *J*, Fig. 2, that engages a hub *H* which, with the four sets of bags, rotates at will on the center support. Consequently when the two sets of bags in front become foul and will not filter, they may be thrown around to the back of the filtering chamber and there left to drain until they can be cleaned. The door is then closed.

The operation of the oil filtration may be seen and the filtering bags cleaned or examined at any time without interfering with the workings of the filter. An electric-light globe *M* is also provided for the proper illumination of the filtering chamber. Steam coil *O*, Fig. 1, encircles the filtering chamber, but the oil never comes in contact with this coil. After the oil is filtered through the bags, it passes on into the water-separating chamber, where the water is automatically separated from the oil by precipitation and flows to the sewer through a suitable connection.

The upper water glass shows when there is water in the oil, before it overflows to the sewer. The gage-glass *U* indicates the amount of clean oil in the filter; the faucet *V* is for drawing off the clean oil, and the opening *Q* is a pipe attachment for an oiling system. The valve *K* lets the water out of the water chamber and is for cleaning. About 2 in. of water should always be in the water glass to seal the automatic water-separating device and keep it in working order.

By removing the tray in the top of the filter and the bags attached to this tray, the filter can be seen down to the bottom and examined and cleaned.

Roybel Packing

A new metallic packing has recently been placed on the market by the Roybel Packing Co., 30 Church St., New York City. Anti-friction metal is used as a base for its composition to which is added a liberal quantity of graphite, also a small percentage of asbestos fiber, in order to thoroughly mix the metal and the graphite. It is said that the metal has the desired density, heat resisting, wearing and noncorrosive quality necessary for a successful packing, and that the liberal use of graphite in its composition improves its wearing qualities and supplies the necessary lubrication to the piston rod.

This packing is made for use with steam, air, gas, ammonia and water and for packing-valve stems, of various kinds.

Under the auspices of the Coal Smoke Abatement Society of England, an international smoke-abatement exhibition will be held in London, Mar. 23 to Apr. 4. Preliminary prospectuses of the exhibition will be loaned by the United States Bureau of Manufactures to those interested.

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POWER

An Evenly Balanced Power Plant

To operate it economically and successfully, an industrial plant, such as a steel works, lumber or textile mill, must of necessity be evenly balanced as to its machinery and the capacities of its different departments. For instance, in a plant where the raw material is worked up through the various phases of its manufacture into the finished product, it would show poor judgment to have one of the intervening departments capable of handling twice the amount of material that the preceding one could furnish or the following one take care of.

In a similar way and for the same reasons, a power plant must be evenly balanced. While there may not be many phases or departments in the manufacture of power, there are always two points that must receive consideration, the fuel intake, or boilers, and the power output, or steam engines, generators, etc. Where a new power plant is to be installed it is an easy matter to so design and select proper equipment that everything will harmonize as to capacity, steam pressures, voltage, etc., so that a perfect balance will result, but making alterations or additions to an old station is quite a different matter.

The rapid progress made in power engineering during the last few years has made it very difficult to keep an old plant uptodate in every respect. Not many years ago 100 pounds steam pressure was considered very good for an average boiler house, while today 150 to 185 pounds is quite common. A power plant built several years ago, therefore, usually has engines suitable for only comparatively low pressures, and should new boilers be necessary to replace the old ones they should be selected with this fact in view. Of course, boilers built for high pressures could be installed and operated at such pressures as the engines would determine, but unless conditions indicate that a higher steam pressure can be used in the near future, it is doubtful if it would pay to tie up a lot of money in the more expensive high-pressure boilers. On the other hand, suppose one of the engines gives out and must be replaced, then the low steam pressure available will deter the purchase of a high-pressure, high-power economical machine. This naturally prevents the owners from obtaining the economical results that modern practice should give, and is particularly true of steam turbines, where high pressures are always desirable.

In considering the purchase of a low-pressure steam turbine to utilize the exhaust steam from a reciprocating engine, it is always advisable to thoroughly examine the engine to make sure that its probable life will justify the addition of the turbine. This point is sometimes overlooked in the great desire to increase the power supply at very little additional operating cost, with the result that after two or three years the engine is ready for the scrap pile and the question arises as to what is the best thing to do. Investigations then usually result in finding that the purchase of the turbine was made without careful consideration of the situation and that the only thing to do now is to get a new engine to work in combination with the turbine, whereas it might have been possible to get a machine more suitable for the conditions in the first place and, perhaps, at considerably less outlay of money.

In such instances it is always well to look ahead a year or two and do a little figuring to see if the economies effected, as well as the better operating conditions that would result, will not justify a broader consideration of the question at hand. It has even been found that it is real economy to relegate to the scrap pile some particular machine or equipment that might still be in good condition but has been superseded by something that realizes a greater decrease in the cost of production and, consequently, a greater saving in the investment. It is also a fact that any particular part of a power plant that tends to retard the op-

eration of the rest of it at its highest efficiency, is an expense that should be avoided by bringing this part of the equipment up to the same standard as the rest.

Get-Rich-Quick Schemes

Anything which would materially diminish the cost of production of power would be of incalculable value in this industrial age. This is so obvious even to the layman that it opens an inviting field for the exploitation of discoveries and inventions which are to revolutionize present methods and make barrels of money for all concerned.

Every little while we receive from an interested or derisive reader a prospectus, catalog or newspaper advertisement of some wonderful invention or discovery, stock in which is obtainable at extremely moderate prices and profits upon which are imminent and enormous.

If these things were worth one-half what their promoters make them out to be, they would not be peddled out in this fashion. There is plenty of money waiting for profitable investment and any man with an invention or discovery of real value in the power field can capitalize it to any reasonable amount when it it indorsed by competent engineers.

A frequent subject of this kind of exploitation is the rotary engine. It is not difficult to persuade the man unversed in mechanics that there are enormous losses involved in the roundabout way in which the reciprocating engine gets its power to the shaft; that the dead center is a source of frightful waste, and that the "gain of leverage" in the rotary type is an important advantage.

The knowing ones appreciate that the dead center and the reversal of motion involve no loss aside from their slight effect on bearing friction, and that no power was ever made or gained by leverage. If the rotary engine ever beats the reciprocating engine in steam economy it will be because of less friction, less clearance and less interchange of heat between the steam and the containing surfaces.

The rotary engine promises no large improvement in steam efficiency. Whatever advantages this type may possess are to be found in high rotative speed, lightness, freedom from vibration, adaptation to certain purposes and perhaps low cost of manufacture. It is impossible to condemn it as one would a perpetual motion, for one may be evolved which may find a profitable if limited field of application; but they will never realize the rosy dreams of their inventors, who usually gain the opprobrium which goes with a lot of disappointed stockholders rather than the proud place by the side of Watt and Corliss in the inventors' hall of fame to which they are already elevated by the prospectuses, most of which read like mechanical joke books to the initiated.

When you are tempted to invest in anything of this kind, get the advice of a competent mechanical engineer. It may cost you a few dollars, but may save you many.

Another favorite get-rich-quick scheme is the magical compound which, sprinkled over the coal pile, will make it burn without smoke and evaporate more water than it is supposed to be responsible for. From a Salem (Mass.) paper we learn that the American Carbonine Co. is now visiting North Shore manufacturers for the purpose of demonstrating the merits of "Carbonine." They mix a pound of chemicals in a bucket of water, spray the solution on the coal pile, shovel the coal into the furnace and make the victim think they save him 25 to 30 per cent.

It is needless to say that if there is any chemical which will do this it costs more than the coal that it would save and that the game is older than "Kem-Kom" and the host of other names that the various compounds so advanced have borne. We advise the tanners of the North Shore not to get in too deeply before seeking competent advice.

England's Alarming Discovery

With loud acclaim, a London press dispatch of Feb. 5 announces the discovery by the British Admiralty of the fact that a recent German engine development threatens Britannia's naval prestige.

This "perfected type of internal-combustion engine, which will make the dreadnaught obsolete and give Germany control of the seas," turns out to be the Diesel engine.

In a letter to the New York *Times* of Feb. 7, Mr. George Westinghouse says that there is no reason to fear an oil-engine navy. In its present stage of development, he contends, the internal-combustion engine cannot operate with the same freedom from accidents and interruptions as does the modern steam engine, turbine or reciprocating. But danger awaits the navy of that country which is depending upon the development of this type of engine rather than availing itself of the present class of machinery.

That the value of artificial ventilation is practically ignored by the lay public, and its many hygienic and commercial advantages are regarded with hostility by most supervisors of public institutions and large office buildings, are very good reasons why ventilating engineers should redouble their efforts to make plain their necessity in engineering.

Operators and owners of isolated plants are frequently criticized for not knowing the value of their plants and not having the necessary data upon which to base the fixed charges. If we are to judge by the testimony of some of the New York Edison Co.'s officials in the rate hearing now going on before the Public Service Commission, it would appear that the small plants are not the only offenders in this respect.

The British Admiralty appears to have quite successfully solved the problem of corrosion in condenser tubes. Notwithstanding the large number of British warships in service, the number of cases of pitting or localized corrosion is very small, and frequently tubes last from ten to twelve years.

In the Atlantic fleet, 620 men learned to swim in one week—they were compelled to do this. If you compel yourself to do something to increase your efficiency, it may mean better wages, a more responsible position.

Two cats were killed at the last boiler explosion in New York City. Men would have shared the same fate had they been in the same place.

Sand for a hot box and "sand" (and grit) in an engineer—well, you can draw a ready inference.

Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Pump Diagrams

The accompanying diagrams were taken from one side of a 16, 28 and 6½ by 24-in. compound, duplex pump running noncondensing and exhausting direct to the atmosphere. The pump runs at a speed of from 32 to 34 strokes per minute, and pumps against a head of 300 to 400 lb. The boiler pressure ranges between 105 and 110 lb. per square inch. The pump makes an actual stroke of but 22½ in.

PUMP DIAGRAMS

I run two 100-hp. return-tubular boilers when running the pump at 32 to 34 strokes per minute, and burn from 32 to 40 bbl. (of 42 gal. each) of oil of 15.6 deg. Baumé, each 24 hours, as fuel. The feed water enters the feed pump at 138 deg. F.

I would like to hear what some other engineer thinks of the plant's efficiency and the accompanying diagrams.

FRANK WILLIS.

Reward, Calif.

Dashpot Repair

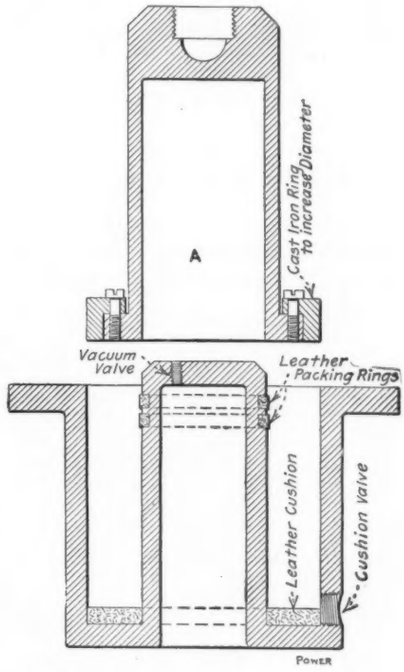
The accompanying sketch shows how a set of dashpots which had acted badly since the engine was first erected, were improved. It was found that when originally bored they had not been cleaned up all around, which prevented the plunger from fitting close enough to confine sufficient air to cushion it.

To overcome this trouble the engineer had to partially break the vacuum in the vacuum chamber, which caused a bouncing action to the plunger. The pot was trued up and two grooves for leather rings were turned as shown in the lower sketch. An ell-shaped ring was turned and secured with cap screws to the plunger. Leather strips were fitted in the grooves and a disk of leather was placed in the bottom of the pot to prevent the plunger making a disagreeable noise when the two metallic parts came in contact.

This change resulted in nice working dashpots.

The quarter boxes on this same engine gave trouble. The adjusting bolts extended down behind the wedges with a right-angle bend and fitted into holes in the wedges which were tapered ¼ in. per inch. This extreme taper caused the wedge to slide down, springing the wedge bolts, sometimes breaking them and causing the shells, wedges and cap to move and wear the frame jaws.

This trouble was overcome by fitting a bar between the wedge top and the cap and tightening the cap-bolt nuts down as hard as prudence allowed without breaking the cap. This makes some trouble when it is necessary to take up the bearing, but this is not done oftener than once in 12 or 18 months.



HOW THE DASHPOT WAS REPAIRED

Two young engineers have been broken in on this engine and each melted out a main bearing. In one case the shop was very busy and a shutdown was not to be thought of, as it was only three weeks away from the annual shutdown for stock taking. I concluded to cut oilways in the shaft. This enabled the engine to run until it was convenient to raise the shaft and rebabbitt the box.

Shaft grooves should be cut in the shape of a number of crescents joined together spirally around the shaft, but never parallel with the shaft or a flat surface will wear on the shaft. Care must be taken to dress the metal near the oil groove to a true circle, either with a fine file or an oilstone. If the shaft is not smoothed properly, the ridges will scrape the bearing metal and ruin the box.

I believe that oil is distributed better when the grooves are in the shaft than when they are in the babbitt.

J. O. BENEFIEL.

Anderson, Ind.

Fool Proof Barring Lever

With the small high-speed engine it is a very common practice to supply a barring lever, as shown in Fig. 1. The guard *A* is fixed on in various ways. While this lever may answer the purpose, it is far from being fool-proof, and one engineman I know spent some weeks nursing several smashed toes before he realized that the lever should not be used as shown at *B*.

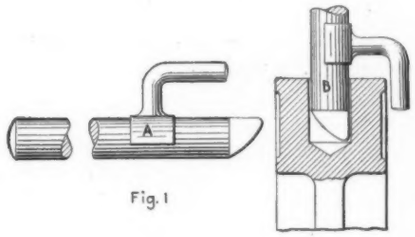


Fig. 1

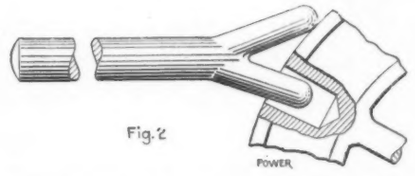


Fig. 2

A much more reliable lever, which I came across recently, is shown in Fig. 2. As will be seen, it is simply a double-pointed bar, easily forged to shape and quite fool-proof. Either point may be inserted in the barring hole of the flywheel; there is no wrong way. If an attempt is made to apply it sideways, as at *B*, Fig. 1, on applying any pressure it swings to the correct position or the reverse and comes out.

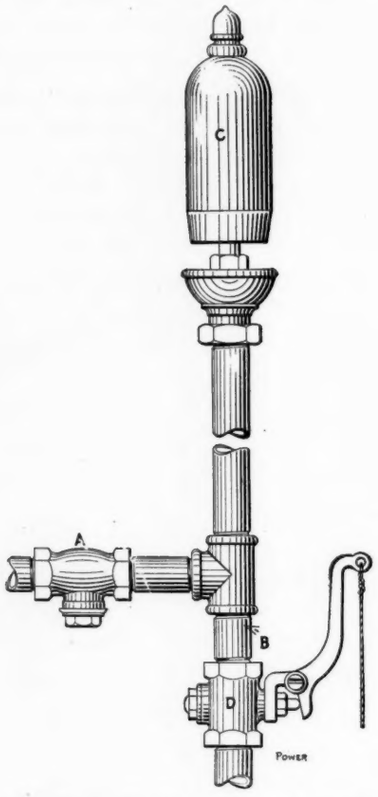
J. PARNELL.

Belfast, Ireland.

Drain for Exposed Steam Whistle

In many factories the whistle valve *D* is in the boiler room while the whistle *C* is outside the building, of course, and several stories higher.

In such cases there is a small valve attached to the steam pipe, operated by hand, which is opened after the whistle is sounded and closed while sounding. Sometimes the operator forgets to open the drain valve, and if the whistle valve *D* should leak ever so little, the steam pipe will gradually fill with water. When the lever is pulled there is a great splatter of water blown from the whistle



ARRANGEMENT OF CHECK VALVE FOR DRAINING WHISTLE PIPE

for some seconds before it will begin to sound. If the weather is cold the water in the pipe is liable to freeze and burst the pipe.

In the accompanying figure it will be seen that a small check valve is attached upsidedown with the outlet side toward the steam pipe. When the lever is pulled the steam pressure rushing into the pipe will close the check and keep it closed until the lever valve closes. The pipe is then empty of water and the pressure suddenly drops, allowing the check to open. A small drip pipe can be attached to *A* and run to some convenient point if desired.

HAROLD BEECHER.

Toronto, Ont.

Design of Water Intake

The writer was engaged to operate a certain plant before it was completed, and consequently he watched its construction closely with a view to making any change that would improve operating conditions.

One such change had to do with the water intake. This was intended to be built as shown in Fig. 1, taken from the

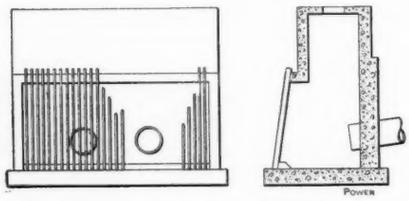


FIG. 1. ORIGINAL DESIGN OF INTAKE

consulting engineer's sketch. This arrangement would be all right at tidewater or for a large lake, but it is not a suitable design to be used in a small stream running through many miles of woodland. The engineer, on pointing out

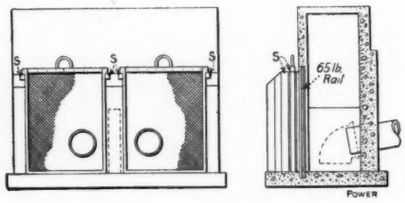


FIG. 2. IMPROVED DESIGN OF INTAKE

the conditions that might be expected and asking to be allowed to change the construction, was told by the superintendent: "Go ahead and build it to suit yourself." Fig. 2 shows how he built it. The piers, extended out as shown,

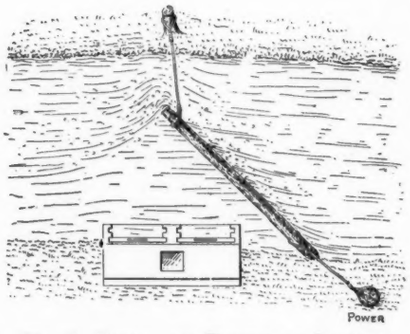


FIG. 3. BOOM FOR DIVERTING LEAVES

were provided with slots *S* for the reception of the screens, the pier in the center being reinforced by a steel rail, in order to guard against possible damage when struck by the large masses of ice which are carried along with considerable speed during the spring thaws.

After the plant had been in operation some time, it became necessary, on account of the water level being lowered, to place elbows on the pipes. This was done without interfering with the operation of the plant in any way. For several weeks this fall, great quantities of leaves were carried along. A boom placed in the position shown in Fig. 3 helped to divert a great many and it was necessary to keep a man at the screen almost continually as it would be completely covered in an hour. In spite of this extreme condition, not an instant's delay in operation occurred.

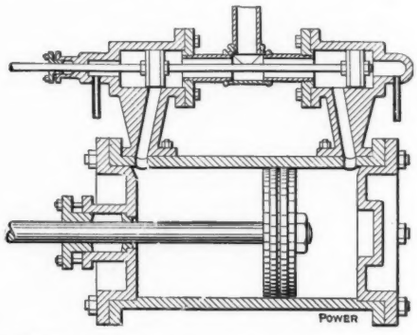
O. M. SAMUELS.

Albany, N. Y.

Supplementary Exhaust Valves

In a certain woodworking factory there is an 18x28-in. double-eccentric, slide-valve engine, running at 125 r.p.m. that has been in service for 12 years.

About five years ago a new engineer took charge, who closely investigated everytning pertaining to the mechanical branch of the plant. In due course of time he indicated the engine and found that at normal load the back pressure amounted to 13 lb. He conducted a



SUPPLEMENTARY EXHAUST VALVE APPLIED TO CYLINDER

series of tests, in order to ascertain the cause, but arrived at no conclusion until he measured the exhaust port and found that it was too small.

An extended correspondence between the engine builders and the firm who owned it ensued, which terminated by the engine company as good as advising the owners to get a new engineer, as the present one did not know what he was talking about.

The engineer kept his job nevertheless, and devised a set of supplementary exhaust valves, which he figured would reduce the back pressure. He tried to induce the owner to finance his scheme, explaining that while the improvement would not cost much it would reduce the fuel bill about 25 per cent.

During the past five years he used every possible argument, but the old man would not be convinced until it was necessary to install new machinery to the extent of about 30 hp. Since the engine was already overloaded, and it was impossible to put up a new engine

while running, owing to the already cramped space, and the fact that they could not afford to shut down, the old man told the engineer that the only way out of it was to put in an electric motor and run it on central-station power for the overload. The engineer, not having much love for the central station, told the old man that if he carried out this plan, he would quit.

By this time the old man thought well enough of him to keep him, and after a lengthy argument he told the engineer to try his supplementary exhaust scheme. The result was that the back pressure was reduced to about 3 lb., thereby increasing the power of the engine about 36 hp. and doing away with the necessity of installing a motor and paying the monthly power bills. The expenses for the improvement amounted to about $95.

The accompanying sketch will explain the working of the supplementary exhaust valve. An opening of 7 sq.in. was made through the cylinder crown into the clearance space. Over this opening or port the valve casting rested, the lower part of which conformed to the shape of the cylinder. The upper part of the casting consists of two cylindrical sections, the larger one containing the piston valve, the smaller one being drilled for a drip pipe, to lead off any steam that might leak by the piston. The exhaust pipe, which is flanged to the valve heads, branched out from the center as shown. Both pistons are on the same rod, which is attached to the main exhaust-valve slide, and are therefore actuated by the exhaust eccentric.

VICTOR BONN.

New York City.

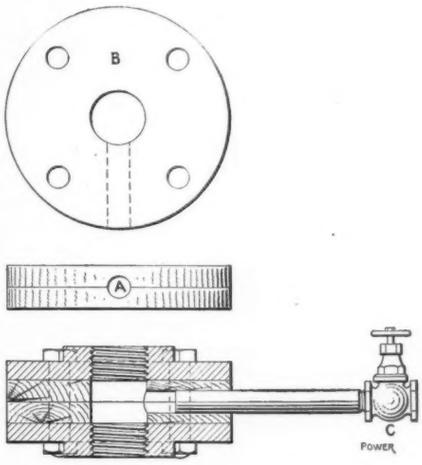
Backwoods Steam Fitting

Some days ago I was in a regular Rip Van Winkle of a steam-power plant away back in the woods. The husky in charge of the outfit looked as if he did not know that he was alive, but that was where my observations led me astray. Another husky, noticeable for the size and height of his boots, strolled up and said: "Ike, I want to use some steam for a few hours over across the room to limber up some wood from the ice."

"O. K.," said Ike, "she will be there in a giff."

I had learned before this that Ike's tool outfit for pipe-work consisted of several disreputable-looking pipe wrenches and some chisels, and I wondered how he was going to get in that pipe.

There was a 2-in. steam pipe close at hand connected with flanges. Ike removed the bolts and separated the flanges, placed a ¼-in. board between them, and marked the holes and circumference of the flanges on it with a lead pencil. Then he walked over to a bandsaw, and in a few minutes had two wooden flanges cut out as shown at *B* in the accompanying figure. He placed them together between the jaws of a wooden vise and bored a hole so that half of it came in the face of each board as at *A*. There was room to separate the iron flanges without danger of springing, and he placed the two wooden flanges between the iron ones.



WOODEN FLANGES FOR STEAM-PIPE CONNECTIONS

He then placed a nipple with a valve attached as at *C* in the hole, and used four long bolts to connect all together tightly.

When steam was turned on there was no sign of a leak. Next, he screwed a length of pipe into the valve and this brought the other end over to where the steam was wanted. The whole operation did not take up 15 min.

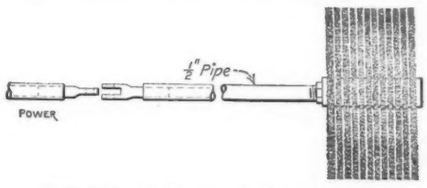
Ike told me that he often ran in a temporary steam pipe in this style, but he had to make new wooden pieces each time, as the ones in use warped very much after they were removed and allowed to dry.

J. JAMES.

Toronto, Ont.

Flue Brush Extension Rod

In taking charge of a plant some time ago, I found that the distance between the boiler-room wall and the boiler fronts was a little over half the length of the



EXTENSION ROD FOR FLUE BRUSH

tubes. When cleaning the tubes the fireman pushed in one section of the brush handle and then screwed the other end in a coupling, which made slow work of the job.

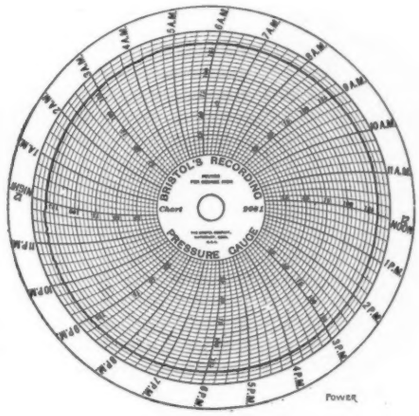
On looking over the scrap pile I found some old duplex pump-valve rods and welded them in each section of the brush handle, as shown, using the same bolt to secure the joint. By making a double joint the end rod can be moved sidewise as well as up and down.

ROBERT B. MASTERS.

Mount Vernon, Mo.

Good Record from Pressure Gage

The inclosed chart was taken from our recording pressure gage. I consider it a record of a very exceptional performance. There are six water-tube boilers in the plant, and the chart was taken from the main steam header in the engine room. It shows what firemen can



AN IDEAL STEAM CHART

do by careful attention and education. The load ranges from 200 to 1400 kw. during the 24 hours' run. The boilers are equipped with mechanical stokers, in which Youghiogheny screening coal is burned. The chart is duplicated nearly every day.

L. C. TOPPING.

Fargo, N. D.

Knock in Boiler Feed Pump

The piston rod of an outside-packed boiler-feed pump stripped its thread on the end that screwed into the crosshead, also the thread in the crosshead, and a new rod and crosshead were made.

When they were made and assembled the pump developed a very hard knock in the inward end of the side having the new rod. The rod was supposed to be of the exact length of the old one and the crosshead travel when running slowly coincided with the marks on the frame.

There was no way to change the valve setting as the valve stem was turned out of stock large enough to form the tappet and was connected to the rocker-arm by a link; there was no way to change the length of the piston rod. The engineer tried placing washers with one side cut out between the tappet and valve ears to reduce the lost motion and thereby shorten the stroke on that end, but

it did no good. Then the wrought-iron rocker-arm was bent so as to shift the valve, but the pound still remained.

There was a ¼-in. hole from the steam port into the exhaust port to gradually release the cushion after the exhaust port was closed. The one on the end where the pound occurred was plugged with soft copper which caused a higher cushion or compression on that end and made the pump run quietly except at high speed, and it was run in this manner for some time.

Shortly after I took charge of the plant, in removing the piston to examine the rings, I found that the piston showed evidence of striking the front head. I pushed the piston up against the head and measured the distance from the piston to the end of the cylinder and subtracting the length of the stroke I found there should be ½ in. clearance on each end. The distance rods and the plunger were disconnected, the rod taken out and a collar made ⅝ in. thick to fit the rod between the shoulder and the crosshead which made the rod ⅝ in. longer. The copper plug, which stopped the knock but did not remove the cause, was taken out and when the pump was started it ran as quietly as one could wish. Upon looking up the sketch of the new rod given to the machinist, the length was given as $\frac{11}{16}$ in. too short.

J. C. HAWKINS.

Hyattsville, Md.

Rhode Island Coal

It may be of interest to know that the Rhode Island Coal Co. has passed into the hands of a receiver. I will add that among some of the "philistines" in this vicinity there has been a feeling that it might be a good purchase for starting an industry for making a fireproofing material out of the product.

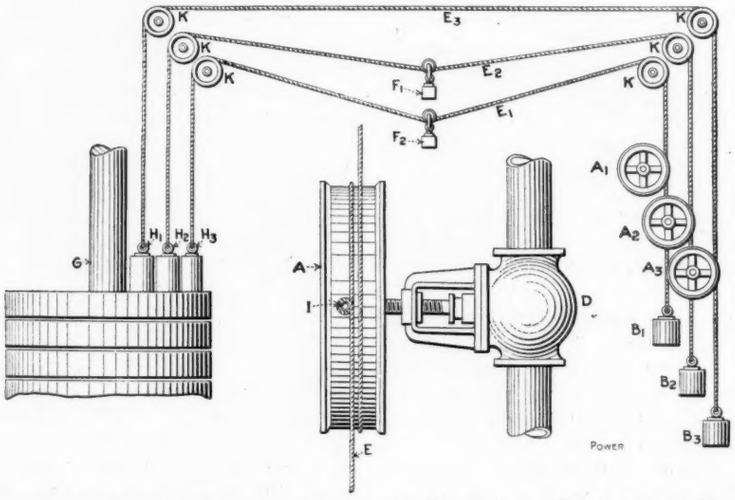
WARREN B. LEWIS.

Providence, R. I.

Step Bearing Pressure Regulator

The accompanying illustration shows an automatic regulator for step-bearing pressure pumps which is simple and reliable, has been in use for three years and has given entire satisfaction. It is here shown in connection with three pumps.

In the steam line of each step-bearing pump and above the hand throttle (although the drum may be placed on the hand throttle, but this is not advisable) is placed the automatic throttle *D*, which is opened and closed by drum *A*, around which is wound one or more times the rope (or cable) *E*, which is looped around the pin *I*, to prevent slipping. On the lower end of rope E_1 is a weight, such as B_1, which closes valve *D* if it is not over-balanced by the weight H_3. The weights F_1 and F_2 are to take up the slack in ropes E_2 and E_1 respectively.



DETAILS AND ARRANGEMENT OF SYSTEM FOR CONTROL OF STEP-BEARING PUMPS

A little experimenting with the pump running and the accumulator up determines the proper adjustment of the rope around the drum *A*.

Assume that the throttles and pumps correspond as follows: A_1 to pump No. 1; A_2 to pump No. 2, and A_3 to pump No. 3; also, that pump No. 1 is running and pumps Nos. 2 and 3 are held as auxiliaries.

The method of regulation is as follows: If the accumulator weight *G* drops, the weight H_1 drops with it, pulls on rope E_3 and opens the throttle wider on pump No. 1 and causes the pump to speed up and raise the accumulator and weights to the normal position, thus maintaining a constant pressure. If for any reason pump No. 1 does not keep up the pressure and the accumulator and weights are further lowered, the slack in rope E_2 is taken up and pump No. 2 is started. If both of these pumps fail, or if the pressure is still further lowered for any reason, pump No. 3 is started in the same manner.

When it is desired to run either pump No. 2 or 3 alone and hold the other two pumps as auxiliaries, all that is necessary is to take up the slack in the rope on the pump to be started, open the throttle and adjust the rope on the drum and around pin *I* to the proper running position (which, for convenience, has been determined and marked beforehand) and let the slack in the rope of the pump to be shut down equal that of the rope of the pump just being started.

T. H. PAYNE.

Worcester, Mass.

Boiler Sheet Bagged

A slight distortion was noticed on the fire sheet of a return-tubular boiler, and as the boiler was free of scale and oil, the cause was a mystery. Everybody about the plant agreed that overheating the plate was the cause, but the boiler was never working beyond three-fourths of its capacity.

The boiler is inspected regularly and the distortion is getting larger and deeper. It now has an area of about 1 sq.ft., starting about 6 in. from the front head, and is fully ¼ in. deep. The inspectors, however, seem to be satisfied as to its safety.

I was visiting the plant one Sunday when the engineer was washing out the boiler, and before he closed the front manhole he put in an ordinary water bucketful of boiler compound without first dissolving it in hot water and right in the depression caused by the bag. Since then there has been no mystery about the formation of that bag. The compound does not readily dissolve in cold water and when a fire is started under the boiler, overheating the plate occurs, as the water does not come in contact with the sheet under the compound.

ADOLF RATHMAN.

Chicago, Ill.

Finger Prints

Finger-print evidence shows whether the men around the power plant take an interest in reading the engineering literature that comes to the engine room. A well thumbed file of POWER in the engineer's office should please any manager.

Finger prints on the bright work in the plant is an evidence of carelessness, but when they are on the pages of a trade paper or on catalogs they show that the owner of the fingers is trying to keep uptodate. In other words, for some finger prints it is not necessary to be ashamed.

A. S. MERRILL.

Easton, Penn.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Underfeed Stoking vs. Overburning

Orosco C. Woolson made some statements in his letter under the above title in the Dec. 12 issue which do not "gee" with my observations and experience.

He seems to fear that the method of supplying air exclusively from below the fire is bound to result in incomplete combustion because "whatever the quantity of air admitted through the grate, it would expend itself on the coke only" to form CO and no oxygen would be left to complete the combustion to CO_2 above the fire. His fear might be substantiated if the air were perfectly and rapidly diffused throughout the fuel bed, but such is not the case. With any kind of furnace and any kind of firing, the tendency of the air is to find channels of least resistance through the fire bed and hence when the draft is sufficiently strong, an ample air supply can easily be maintained.

The importance of an intimate mixture of an ample supply of air with the volatilized combustible matter of the fuel is emphasized in one of Mr. Woolson's paragraphs. In what better way could this be accomplished than by forcing the air up through the fire along with the combustible volatile matter? This is what takes place in the underfeed stoker; the air enters the fuel bed at the lower side of the combustion zone along with the gasified hydrocarbons that have been distilled from the green fuel underneath by radiant heat. The air and hydrocarbons pass upward together through the fire, intermingling as they go.

The probable reactions are as follows: The hydrocarbons burn to CO_2 and H_2O and are immediately broken down again to CO and H while passing through the fire zone. In the fire zone there is, then, incandescent solid carbon, CO, H, free O and N. Emerging from the fire zone, the gases cool until the hydrogen burns to H_2O again and the CO to CO_2.

When combustion takes place at ordinary rates, excess air must be supplied or else the diffusion will not be rapid enough for each molecule of oxygen to find and combine with its molecule of CO before the gases cool beyond the combining temperature.

In conclusion, I should like to point out, as proof that underfeed stoking is as efficient as practically any other method of firing, that good results are being obtained with such installations in plants all over the coal-burning sections of the country. To cite just one case, a recent test of a 540-hp. boiler equipped with underfeed stokers in a large power plant in the Middle West indicated a combined efficiency of over 80 per cent.

PHIL LIGHTE.

Woodhaven, N. Y.

What Means the Dome?

A. A. Blanchard, in the Jan. 23 issue, tries to explain the purpose of the dome on a logging engine shown in POWER for Dec. 26, but I do not believe that Mr. Blanchard's explanation is the true one.

If a dome of unusual height were necessary for the little hill climber, why was it necessary to go to the expense of cutting and drilling the boiler sheet when the builder or owner could have easily increased the height or removed the one shown near the cab and riveted a longer one in its place?

If Mr. Blanchard will examine the picture again he will see a heavy flange riveted on the side of the dome near the top. Judging from its appearance, this flange was tapped for a 2-in. pipe at least, which, I think, was for some other purpose than to relieve the boiler of steam when cooling down for repairs.

J. W. DICKSON.

Memphis, Tenn.

Engine Load Not Equalized

In regard to Mr. Gordon's compound-engine diagrams in the issue of Jan. 23, I suggest that he shorten the cutoff in the low-pressure cylinder, thereby giving it a larger share of the total work and decreasing that done by the high-pressure cylinder.

By making the low-pressure cutoff earlier, the receiver pressure is raised and consequently the back pressure in the high-pressure cylinder is increased, decreasing the work done in that cylinder. The adjustment of the low pressure cutoff does not affect the engine's total work, as this depends upon the amount of steam admitted to the high-pressure cylinder and the total number of expansions occurring in the entire engine, both of which factors are constant with constant high-pressure cutoff.

The receiver pressure which gives equal distribution of work between the cylinders, may be determined by the cut-and-try method of taking diagrams for several adjustments of the low-pressure cutoff until one is found which gives diagrams showing equal power.

HENRY E. CHAMBERS, JR.

Buffalo, N. Y.

Setting Valves on Corliss Engine

In the article under the above heading in POWER for Jan. 23, the setting of the safeties is not considered. I think that the proper adjustment of the governor so that the safeties will operate at the right time is much more important than the equalization of the points of cutoff.

When I adjust the governor on a Corliss engine, I first raise the governor to its highest position and block it there. I then adjust the governor rods until the knock-off cams will just prevent the latches from hooking on when the wrist-plate is rocked back and forth. Then, I lower the governor to the running position and block it there. If I find that the points of cutoff are uneven, I shorten up on the end having the longest cutoff. By shortening the longest end, the knock-off cam is still sure to take effect when the governor is in its highest plane.

After thus equalizing the two ends, I lower the governor to its lowest position and adjust the safety cams so that the latches will not hook on with the governor in this position. If these adjustments are properly made, the engine should not overspeed when losing a load or when the governor belt breaks or runs off the pulley.

I once took charge of an engine which apparently was adjusted without thought of the safeties. At the first opportunity, I adjusted the governor so that the safeties would operate. For this I was soon to be thankful. This engine and a water-wheel were connected to a factory load. The belt on the engine was quite loose, although it did not slip, as far I was able to observe.

One day the gate of the waterwheel dropped, due to the rack connected to the gate being worn out. This threw the whole load onto the engine, which also had to drag the wheel. This load was too much for the loose belt, and as I came through the engine-room door I was in time to see the belt slip from the pulley into the pit. This was when I was glad

that I had changed that governor. I could not notice any increase of speed to speak of; the governor simply went up and the engine did not take steam for a few strokes.

LESTER A. FITTS.

West Fitchburg, Mass.

Wanted: Engineer of Pleasant Disposition

Mr. Morton, in the issue of Jan. 23, takes exception to an advertisement in which an engineer of pleasant disposition is asked for. From his remarks it will be inferred that the engineer must be cross or surly who would fight for his rights. If I were an employer and had the misfortune to hire a man to run my plant who was always finding fault and dissatisfied with everything, I should get rid of him as soon as possible.

I have had assistants in steam plants whom nothing could satisfy, and if they were not kicking, they were trying to throw cold water on any new arrangement or plan that we wished to try out. What a contrast there was between these men and those who were trying to make the best of their lot; the former were in a rut of inefficiency while the latter were "making good." I do not mean that a man should try to be contented under bad conditions, but he should seek to improve his position; he cannot gain success with an ugly or combative personality.

We are led to believe that a man with a pleasant disposition will not have the backbone or brains to stand up for his rights. This may be true in some cases, but if he lacks the brains to do that, how long will he last while running a plant?

Mr. Morton also says that such men "do not know their business as engineers; consequently they cannot explain their duties to their employers." It is not necessary that a man should have a surly disposition to prove his worth to his employer or to place him on good terms with those around him.

In our business, engineers who allow an unruly temper to get the best of them are not making a success. Each in his own experience can remember perhaps some chief he had who in time of trouble did not fly into a passion but quietly gave his orders and had everybody working hard to help him out. While I realize that in such times it may be quite the proper thing for a chief to try to "rip things up," I doubt if this method ever benefits the right sort of help.

An engineer need not be a "man-eater" to get his rights; if the firm wishes to be fair, it will listen to him much more patiently than to one who threatens or whines.

G. H. KIMBALL.

East Dedham, Mass.

Engineer's Reference Book

I have been much interested in reading the letters on "Engineer's Reference Book," having started a book of this character some 15 years ago. After carrying it on for about three years, I found that it got too bulky and consumed too much time. I made a practice at first of writing in this book the gist of the matter from various articles for ready reference. But it became a decided nuisance to transcribe the necessary material, and not infrequently I left out a great deal of information which later I wished I had on file. Then I gave up the book and started in along totally different lines.

I divided my material into three general groups: First, a data book solely on costs, in which every quotation I received was placed, with full information regarding the machinery, its cost and the date of the quotation, reducing the figures when advisable to unit costs. Second, a scrap book in which I pasted the clippings of interest from the engineering magazines, carefully indexing this book. Third, a filing system for clippings from engineering papers or magazines which were too large or bulky to be conveniently placed in the scrap book. For the latter there was no separate index; the folders themselves served this purpose, as on the edge of each, where it protruded from the file, was marked the subject in that folder.

While this does not give me a reference book that I can readily carry in my pocket, it is very easy to collect such information as I may need at any time and take it with me, and I can put my most valuable and frequently used information into a small loose-leaf notebook.

The great thing is to obtain information not only on a subject which may be of interest at the moment, but also on all subjects of allied interests, and to keep posted so far as is possible on all engineering subjects.

An engineer in a shoe factory may be looking for all the information he can obtain regarding the general operation of shoe-factory plants, and then he may be transferred to some other character of plant. If his information does not cover the character of plant to which he is transferred, he will be more or less at sea, except so far as the engine room is concerned.

If, however, he has kept posted on not only the operating features of the first plant, but also on the costs of the apparatus, including not only the engines, pumps, boilers, piping, etc., but also the shafting, pulleys, belts, oil, hangers, cost of operating the various machines, etc., in the shoe factory, and the cost of operation of the various machines in other types of factories, he will be of considerable value outside of just the power plant. Such information will enable him to prove his value and step upward.

There is always a good deal of information to be obtained on methods of keeping track of the operating features of plants as well as determining the fixed charges; and if a man proposes to be of service, he should know the fixed charges, as these have a material bearing on the cost of power. The more he knows, the more valuable he is to his employer if he uses tact in demonstrating his knowledge.

HENRY D. JACKSON.

Boston, Mass.

Fuel Economy and CO_2 Recorders

I read with interest A. D. Williams' discussion on "Fuel Economy and CO_2 Recorders" in the Jan. 23 issue, in which he attacks the accuracy of the intermittent type of recorder.

I will not attempt to state which of the three types of recorders mentioned is the best, but I would take exception to his reasons why the intermittent type is objectionable. One of his reasons is that the recorder takes samples "at intervals of from 5 to 10 min. or more" and the serious disadvantage arising from this is that the firemen can cheat; that is, he "can approximate the time interval and lag of the apparatus and so arrange his work that the admission of surplus air to his furnace occurs during the periods when samples are not being taken."

If this were the case, it would be a serious objection; but with the uptodate type of intermittent recorder—which is almost continuous and may be handled by anyone of ordinary intelligence—there is no excuse for the time interval between the recording of two consecutive samples exceeding 2½ min. The time is really only about 1½ min., as the analyzed sample is drawn for a period of about 1 min. from the continuous stream of gas flowing from the gas passage to the recorder.

There is no way for the firemen to know when a certain volume of flue gas is in the sampling pipes, and if he did, he would be clever if he could bring about changes in the fires which would be to his advantage and happen in an interval of 1½ or 2 min. If a fireman who receives a bonus for a high percentage of CO_2 would attempt this he would find the percentage going down instead of up, especially if one recorder were connected to six or more boilers.

Another disadvantage of the intermittent type which Mr. Williams states is that the "interval has to be sufficiently long to permit the potassium-hydrate solution to absorb the carbon dioxide, and as a fresh solution acts more rapidly than one nearly saturated with gas, the time must be fixed to suit the slowest-

acting solution." I will admit that in some of the unsuccessful makes where the CO_2 must be absorbed by the gas coming in contact with the surface of the potassium hydrate, this is true; but where the gas is made to bubble through it there are no grounds for this objection.

CHARLES M. ROGERS.

Detroit, Mich.

Central Station vs. Isolated Plant

The last third of a century has witnessed a marvelous development in the realm of power generation and transmission, and unavoidably in the connection there has been a great readjustment of conditions under which men are employed. As a result, some positions have been abolished, and it is but human that the men displaced should feel unkindly toward the direct cause of their misfortune. According to some criticisms, it would appear that the central station is a monster going about devouring engineers' jobs, and is so insatiable that it must get them regardless of the means required. Is it any wonder, then, that engineers have taken up arms against this monster? It is doubtless true that the central station, in finding its legitimate field, sometimes oversteps the boundaries. In such cases the pen is the proper weapon for driving it back.

Many of the articles have, probably unintentionally, paid the central stations a decided compliment and offer a ray of hope for the displaced employee. The compliment is the reference to the trained solicitors which the central stations are credited with employing, and the ray of hope is the thought that a new field has been opened for men with engineering ability. These trained solicitors must necessarily have a knowledge of engineering, and while not all engineers can become central-station solicitors when their positions are abolished, they have the consolation that the solicitor who took their jobs away is not himself an engineer seeking the same jobs.

When central-station solicitors use misleading arguments and misrepresent matters in order to attain their ends, their methods should be condemned in no uncertain words, but when the facts are on their side and the user of power would clearly be the gainer by the installation of central-station service, the engineer should humbly submit.

Is it not true that with the development of central stations the field for steam engineers has been enlarged, and that a larger percentage of the working population is today employed in that work than ever before? Today every town of any size has an electric-light plant, and in many instances the engineers employed are in addition to the number that would be working in those towns were there no lighting plants.

Perhaps electric-railway power plants are not exactly included among the central stations referred to, but their development has been a part of that of the electrical line and they have created many places for steam engineers that would not have otherwise existed. In but very few instances have the electric railways displaced any other employers of engineers; instead, they have opened up an entirely new field not only for the employment of engineers but also for many other workers.

In reading these articles the writer has frequently asked himself, are the engineers more fair and conscientious in this matter than those they condemn? When the question of installing central-station service comes up, do the engineers calmly consider the matter and set about determining whether it will be advantageous to put in the service, and if it will clearly be to their employers' interests? Do they honestly admit it, or do they use every argument at their command to induce their employers to retain the steam plant to their disadvantage? Every plant is a problem by itself and careful figuring is required to determine whether it should be abolished.

Engineers should endeavor to be as fair as they wish others to be and be thankful for the fact that undoubtedly there are more opportunities for good engineers in this country today than ever before, even though in their immediate vicinity some positions have been closed. The writer does not wish to be understood as accusing engineers of lacking integrity, but his acquaintance with both engineers and central-station men leads him to believe that the one is as likely to err as the other, and that both professions rank as high morally as most others.

G. E. MILES.

La Jara, Colo.

Smoke Prevention with Steam Jets

In the Jan. 16 issue, J. A. Switzer's article under this title unquestionably deserves the attention of the operating engineer. Near the bottom of page 76 in the first column, the draft is given as follows: Draft gage near stack, inches of water, 0.32, 0.29; and near the bottom of page 78, draft at breeching, inches of water, 0.17, 0.19.

These two readings for each plant represent all the draft information for the four tests. Draft information is very important and no report pertaining to a furnace can be of value without it. Engineers of a few years ago omitted it because they did not know much about it. The statement of draft as given does not convey any real significance at all and the reader is no better off for its being there.

To be of value, draft must be read in the stack, in the breeching at each side of various turns, at both the stack and the boiler sides of the damper, at every pass, whether horizontally or vertically baffled, in the combustion chamber, over the fire and in the ashpit, as shown in the sketch.

The meager information given about the draft is synonymous with stating that there was 10 lb. pressure near the point of cutoff. This certainly would not convey any idea about the actual performance of the engine.

Knowing the height of stack, the draft reading at the stack indicates whether it is over or underloaded or of just the right proportion. If the stack shows very much less draft than it should, it must be overloaded (excessive friction) or very much underloaded (lacking sufficient temperature), and this can be determined by knowing the load.

Readings at the breeching convey the idea of its design as to size, insulation and restriction. Damper readings are necessary to know if the damper is of the desired size to accommodate the gases, and readings at different passes are necessary to know if there is not undue restriction. The reading over the fire shows whether useful work is being done, and all combined will show whether too much air or too little is being admitted. High reading over the fire and no drop or a small drop through the boiler indicates practically static draft at the fire and little or no work is being accomplished. A small drop through the fire and a large drop through the boiler and breeching will indicate large negative work and consequently a large surplus of air.

Where the stack is as close as possible to the boilers, a draft in the breeching of 0.3 or 0.4 in. is very small and there must be something very extraordinary at the Knoxville plants, as both stacks appear from the photograph to be more than 100 ft. high. Usually about 50 per cent. of the breeching draft should be available over the fire. In this case the very most that can be expected for the Knoxville Ry. & Light Co. plant is about 50 per cent. of 0.32 or 0.16 in. This is a very poor draft indeed. In the second test there is 0.29 in. in the breeching and possibly 0.145 in. over the fire.

From practice it can be stated that to burn coal economically at least 0.01 in. of pressure difference must be provided over the fire for every pound of coal burned per square foot of grate surface per hour; that is, if 15 lb. is to be burned per hour per square foot, the draft over the fire must be at least 0.15 in. Hence it will be seen that 0.16 in. will not burn very much coal with economy. This

holds good between 18 and 25 lb. per square foot per hour.

The second very important item missing is the rate of combustion; that is, the number of pounds of coal burned per hour per square foot of grate surface. But knowing the coal burned, the time and the average number of square feet of grate, it can be found.

On the test without steam jets at the Knoxville railway plant there were 270 sq.ft. of grate surface, on which, in 11 hours, was burned 74,213 lb. of coal. This makes the rate of combustion

$$\frac{74,213}{11 \times 270} = 25 \text{ lb. } (nearly)$$

In the second case, 56,700 lb. were consumed during 11 hours on 262.5 sq.ft. of grate surface, making the rate of combustion

$$\frac{56,700}{11 \times 262.5} = 19.64 \text{ lb.}$$

At the Knoxville Cotton Mills, during the test without steam jets, 20,313 lb. were consumed during the nine-hour test on 175.5 sq.ft. of grate surface, making the rate of combustion

$$\frac{20,313}{9 \times 175.5} = 12.86 \text{ lb.}$$

With steam jets working during the nine-hour test, 18,188 lb. were consumed on 131.5 sq.ft. of grate surface, making the rate of combustion

$$\frac{18,188}{9 \times 131.5} = 15.4 \text{ lb.}$$

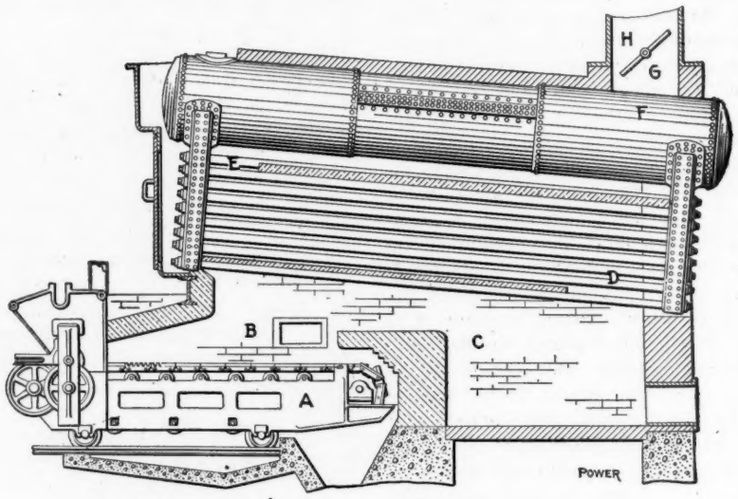
Draft in the breeching at the cotton mills, as given in the first instance was 0.17 in., of which possibly 50 per cent. over the fire would be 0.085 in., and in the second case, 0.19 in., of which 50 per cent. over the fire would be 0.095 in.

As stated before, the rate of combustion depends on the draft, and for each pound burned per hour per square foot of grate is required at least 0.01 in. Having this in mind, examine the data obtained:

KNOXVILLE RAILWAY & LIGHT CO.

1	No steam jets, rate of combustion, lb.	25
	Possible draft over the fire, in.	0.16
	Desirable minimum draft, in.	0.25
	Difference between desired and actual draft, in.	0.09
	Shortage in percentage, per cent.	0.56
2	Steam jets, rate of combustion, lb.	19.64
	Possible draft over fire, in.	0.145
	Desirable minimum draft (0.01 × 19.64), in.	0.196
	Difference between desired and actual draft, in.	0.051
	Shortage in percentage, per cent.	45

From this it can be seen that the trial with steam jets was conducted with 45 per cent. lack of draft, and without the steam jets it was 56 per cent., or, draft conditions were better with the steam jets by 11 per cent. As will be explained further, steam jets have nothing to do with draft itself.



A = 0.06 E = 0.47
B = 0.28 F = 0.62
C = 0.33 G = 0.77
D = 0.37 H = 0.79
Normal Draft Readings in Inches of Water

POINTS AT WHICH DRAFT READINGS SHOULD BE TAKEN

Now examine the second case.

KNOXVILLE COTTON MILLS

1	Trial without steam jets, rate of combustion, lb.	12.86
	Possible draft over the fire (50 per cent. of that at the breeching), in.	0.085
	Desirable minimum draft over the fire, in.	0.1286
	Digerence, lb.	0.0436
	Lack of draft in percentage, per cent.	50
2	Trial with steam jets, rate of combustion, lb.	15.4
	Possible draft over fire, in.	0.095
	Desirable minimum draft, in.	0.154
	Difference, in.	0.059
	Lack of draft in percentage, per cent.	60

From this it appears that in the case of the Knoxville Ry. & Light Co., the firemen were overcrowding the fires; that is, the lack of economy was due to heavy firing and lack of air. In the second case, the lack of economy was due to too much air, as it is well known that 12 lb. per square foot of grate per hour will not keep the grates properly covered, and this is shown by less breeching draft, indicating negative work (excess air). With steam jets, when the rate of combustion increased to 15 lb. the breeching draft was raised to 0.19 in., showing a smaller surplus of air than during the first test.

A rate of combustion less than 18 lb. per square foot per hour is always conducive to a very large amount of gas per pound of coal and cannot be recommended for the reason that sufficient furnace temperature cannot be obtained, and the gases run as high as 35 lb. or more per pound of coal. Steam from a steam jet with a nozzle opening of $\frac{1}{16}$ or $\frac{3}{32}$ in. expands to atmospheric pressure within 5 ft. from the nozzle and the hand can be held 6 ft. from the nozzle without any discomfort. From this it is apparent that steam jets cannot blow any soot from the tubes, but they prevent the formation of soot by assisting in obtaining a better mixture in the furnace. That is all steam jets are good for; whether they pay for themselves in doing this is rather doubtful, but there is no doubt that they do not add to economy.

Steam jets do not affect the draft and their action cannot be detected at any other point with a draft gage except over the fire, and then only when the fires are too heavy or the point where the draft is taken is in the immediate neighborhood of the jet discharge.

So far as an economy of 10 per cent. of fuel goes, the steam-jet man must be given credit for doing the right thing at the right place in these two cases, obtaining the same result by different changes in the two furnaces. In one case the rate of combustion was decreased, avoiding the static draft, and in the second case the rate of combustion was increased, so as to have less air holes and a better temperature, and the credit for the whole change is given to the steam jets.

HENRY MISOSTOW.

Chicago, Ill.

Brick for Boiler Walls

Referring to Mr. Scheiderer's letter in the issue of Jan. 9, we have a boiler in our plant with an outside wall built of hollow cement blocks. They have proved satisfactory as an outside wall, giving a neat appearance to the boiler room, which is the only benefit I can see in their use. These hollow cement blocks will stand a good bit of heat, although they will not do for firebox work.

LAMOTT R. LEONARD.

Uniontown, Penn.

What we want at times is an alarm clock that will not only wake us up, but will make us feel like getting up, says *Printing Trade News.*

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Steam Pump Valves

What is meant by a pump with steam-thrown valves?

D. O. L.

In direct-acting steam pumps a rotary motion is not developed by means of which an eccentric can be made to operate the valve. It is therefore necessary to reverse the piston by an impulse derived from itself at the end of each stroke. This cannot be effected in an ordinary single-cylinder pump with a single valve, as the valve would be moved only to the center of its motion and then the pump would stop. To overcome this difficulty a small plunger or piston is provided to move the main valve of the pump. In some pumps a small auxiliary slide valve actuated by a piston rod through levers, operates the valve piston. This piston, carrying with it the main valve, is thrown over by the steam and the pump is reversed.

In other pumps, the valve piston or plunger is operated by the main piston striking valves or tappets located at each end of the cylinder. The tappets open a port leading from the ends of the valve plunger directly to the exhaust, thus relieving the pressure at that end of the valve piston. The expansion of the steam at the opposite end of the piston, causes it and the valve to change its position, and reverses the direction of travel of the main piston.

Discharge of Water from a Pipe

What is the formula for figuring how much water a given size pipe will discharge per minute under a given pressure?

A. D. P.

For a pipe running full the formula is

$$Velocity = c\sqrt{\frac{diameter}{4} \times slope}$$

When the velocity is in feet per second, the slope is the head (or pressure expressed as a head in feet) divided by the length of the pipe in a straight line from end to end; c is a constant varying with the character and diameter of the pipe, and the slope, from 69.5 for 6-in. rough pipe to 171.6 for a 20-in. smooth pipe. The tables for the value of c can be found in any engineers' reference book. The amount of discharge in cubic feet per second can be found by multiplying the velocity determined above by the area of the pipe in square feet.

Fusible Plug in a B. & W. Boiler

Where should a fusible plug be placed in a Babcock & Wilcox boiler?

H. S.

It should be placed in the upper drum, not less than 6 in. above the bottom, and over the first pass of the product of combustion; it should project in the sheet not less than 1 in. This rule was formulated by the Massachusetts Board of Boiler Rules.

Size of Wire for Induction Motors

What size wire would be required for secondary street mains to supply two 5-hp. and one 1-hp., 220-volt, 60-cycle three-phase induction motors located 235 ft. from the transformer?

W. C. M.

No. 8 B. & S. weather-proof wire could be used and come within the insurance rules, but the energy loss would be nearly 5 per cent. No. 6 has an energy loss slightly under 3 per cent. No. 4 would be the best size, as the energy loss would be only 1¾ per cent. and the voltage drop about 2 per cent. at full load.

Transformer Connections

Why has a transformer six terminals to its coils when there are only two windings?

J. J. C.

The secondary winding is divided into two distinct coils, which may be connected in series or in parallel, whereas the two primary coils are connected permanently in series. When connected in series the secondary coils give twice as great a voltage as when connected in parallel. The two ends of each secondary coil are run to the outside of the case to be connected as desired.

Saturated and Superheated Steam

When does steam cease to be saturated and begin to be superheated?

A. P. H.

This occurs as soon as the temperature of the steam is raised above that which is produced when it is evaporated. For example, the temperature of steam evaporated under a pressure of 130 lb. (absolute) per square inch is 347.4 deg. F.; if it be heated above that temperature, it is said to be "superheated."

Critical Data

What is meant by critical data of gases?

P. McQ.

There appears to exist for each gas a temperature above which it cannot be liquefied, no matter what amount of pressure is used. This is called the critical temperature. Below this temperature all gases or vapors may be liquefied if sufficient pressure is used. The pressure which causes liquefaction of a gas at or as near below the critical temperature as possible is called the critical pressure. The critical volume of a gas is its volume at a critical point, measured with its volume at the freezing point, under the pressure of an atmosphere as a unit. The critical temperature, pressure, and volume are frequently referred to as critical data. For example, the critical data of carbon dioxide are: critical pressure, 1131.9 lb.; critical temperature, 87.8 deg. F.; critical volume, 0.0066.

Repairing Commutators

What material is best to fill the holes between the commutator segments when the mica has become dislodged?

A. V. C.

Prepare a mixture of powdered mica and thick shellac; set it on fire to burn off the alcohol, taking care to prevent the shellac from charring. When burned sufficiently, extinguish the flame by covering the receptacle with a piece of tin. Apply the paste as quickly as possible, pressing it into the cavity with a heated screwdriver or knife.

Short Circuiting a Shunt Wound Generator

If a shunt-wound generator is short-circuited at the brushes, which would burn out, the armature or the field coils? In what case would the field coils be burned?

A. L. P.

If anything burned, it would be the armature coils, but with some machines the external characteristic is such that short-circuiting kills the field before the armature is damaged. The shunt-field winding could not be damaged by short-circuiting at the brushes under any conditions.

Reminiscences of an Engineer

By Schuyler G. Hooper

Wherein are related some of the things an engineer should not do, and some practices which may assist others who know no remedy for similar troubles.

I had been chief engineer and fireman for six months in a laundry, had studied some and thought I could run anything moved by steam. One Sunday morning an ad appeared in the local paper which read:

WANTED—Engineer to take care of Corliss engine; must be sober and industrious; salary, $75 per month.

I applied for and secured the job. The plant consisted of two 200-hp. Stirling boilers, one 16x42-in. Corliss engine, one 60-kw. dynamo, two 4-ft. Sturtevant fans, a small air compressor and several minor appliances. The engine was belted to a countershaft which in turn was belted to the dynamo and fans.

I was to start the plant the next morning, so I hurried away and secured a man to take my place at the laundry; then I took him to the manager and tried to explain things. Well, I received a lecture that I will not forget right away.

When Trouble Began

The next morning at 5 o'clock I was at the new job and started my first Corliss engine. The foreman showed me how to adjust the voltage by turning a handwheel on the front of the switchboard, and several other things which he had seen my predecessor do. The ding of the dashpots was music to my ears and I was proud of myself until about 9 o'clock, when all at once the dashpots quit their music and the engine slowed down. I could not find any hot boxes, and the steam gage which was on the wall showed 125 lb., which was more than sufficient.

I tried to start again, but the engine promptly shut down when the load came on, and I was more than worried. The fireman reported 140 lb. of steam and said that the pressure was rising in spite of the fire-doors being open and all the draft cut off. He said the safety valves had always "popped" at 126 pounds.

The Gage Pipe Freezes

The superintendent, who had been watching me, was getting ready to leave in a hurry when I said that there was something wrong with the gage. It was an extremely cold day and the gage pipe, which ran across the ceiling and then down to the gage, had frozen and the expansion was raising the pressure. When the pipe was thawed there was 45 lb. pressure. In 15 min. things were going all right once more and I had the gage moved to the front of the boiler where it belonged. The engine had been shut down for an hour, when the trouble should have been located in five minutes.

Hot Bearings

At about 10 o'clock I made a round and examined all the bearings, and when I placed my hand on the main bearing I scorched my fingers. It took me the next two hours and enough cylinder oil to last the engine a week to get it back to normal.

I had closed the oil cups during the shutdown and I had forgotten to open them when I started again. All this trouble had taken some of the confidence out of me, and I was as tired at noon as though I had worked hard all day.

A Circuit-breaker Incident

Things went quite smoothly that afternoon and the next day, although a circuit-breaker kicked out when I was in front of the board and nearly scared the wits out of me. I threw it back before I knew what I was doing and held it a few moments; then I noticed that the ammeter only registered about half load. While I was wondering what caused the load to fall off, the superintendent came in and told me that, for no apparent reason, about half of the fuses had blown out in the foundry. I did not know why they had blown until I had figured it out in bed that night, and then it was very simple. I had thrown the circuit-breaker back before the starting-levers on the motor-starters had a chance to drop back. This had caused the current to rush into the armatures of the motors without any resistance, and, of course, had blown the fuses. I did not tell the superintendent the cause of that half-hour shutdown in the foundry, but the next time the circuit-breaker went out I let it rest a while before throwing it back.

Whenever I had a little time, I studied and examined things about the place. I found out that the handle on the switchboard which regulated the voltage was fastened to a resistance box which was in series with the shunt field of the dynamo, and regulated the current that passed through it.

The plant was about 400 ft. from the foundry and 500 ft. from the office, and there was no steam in either for heat. Just before I came a tee was placed in the exhaust line and also a back-pressure valve. A 4-in. line was carried from the tee to the office, and several weeks after my arrival the radiators were installed and everything was ready to turn on the steam.

The Superintendent Lends a Hand

One morning I slowly opened the valve on the 4-in. line and then started to put some weight on the back-pressure valve, the arm of which was tied with a rope. While I was hunting for the weight the superintendent, who had come in to see the heat turned on, cut the rope which held the lever to the valve. The engine immediately started to slow down and I rushed for the throttle and had it about half closed when there was an explosion and the room was filled with steam. I finished closing the throttle as fast as I could and then ran outside.

There stood the superintendent, looking a little whiter than usual but not hurt in the least. As soon as the steam permitted, we again entered the engine room and found the cover plate on the front of the heater broken in three pieces. Nothing else appeared to be out of order, but I thought there was something wrong with the back-pressure valve, so I tied it back with the rope, and started up again. Everything was all right except that I had to feed cold water to the boiler, which taught me that a feed-water heater was an economical adjunct to the engine room.

The Steam-fitter "Quits"

That night I took the top off of the back-pressure valve and found that the steam-fitter had placed it on upside down. I should have noticed this, but I had never examined one before, so the company lost by my inexperience. The steam-fitter was given a chance to look for a new position the next day, and I was a little shaky about mine, but nothing happened. The valve was correctly placed and the broken heater repaired; that ended that incident.

Dashpot-plunger Troubles

Several days later I noticed that the dashpot plungers did not pull down as far as they should and the hook would hit them and make a noise, so I promptly oiled them and they worked quite well until the next morning, when they were more sluggish than ever. I again oiled them with engine oil, but they did not operate properly. I worried along with them that day, but I hated the thought of starting the next morning as they were always much worse on cold mornings.

That night I purchased my first copy of POWER from a newsstand and while

reading over some of the other fellows' troubles and remedies, I ran across one which fitted my case exactly. It was this: "Never use oil on the inside of the dashpot which has a leather cup on the plunger, as it will gum the leather, cause the plunger to stick and eventually entirely ruin the cup. Use, instead, a little kerosene once in a while, and no trouble will be experienced." The kerosene did the work next morning and POWER received a year's subscription by mail.

All of the lifting in the foundry and machine shop was done with air furnished by the compressor in the engine room. One day a salesman came in with the superintendent and proposed to furnish us all the air we wanted for nothing; that is, without any increase in the fuel bill. He proposed to place a cylinder back of the engine cylinder and carry the tail-rod right through to operate it. He told me the engine had considerable compression, and that he would eliminate it and catch the heavy moving parts with the compressed air. At that time I hardly knew if compression was a contagious disease.

His First Indicator Diagram

The salesman then proceeded to take some indicator diagrams (the first I had ever seen taken) and explained things so clearly to me that I asked the superintendent to let him put in his compressor. He soon had the compressor in; it worked fine and cut the fuel bill a little. However, there was one trouble which I could not overcome; that is, the engine would pound whenever the compressor suction valves were held open by the governor, due to the pressure rising too high in the air receiver. This, of course, was due to lack of compression and a small amount of lost motion in the different bearings.

A Two-day Shutdown

The two 4-ft. fans used were located in the foundry and were run by motors. These motors were too small, and one day a motor burned out an armature, causing a partial shutdown for a couple of days. A consulting engineer was called in and he advised moving the fans to the engine room and driving them from a countershaft. He was asked if the friction in the pipes, when the air passed through, would not make them take more power, but he explained that they would take less power, and he proved his argument by closing a damper in the discharge pipe of one of the fans; the ammeter immediately showed a great falling off in current.

The fans were moved, and when they were started in their new position it was found that while they ran at the same speed as before, they did not deliver as much air to the foundry, so larger pulleys were bought and the fans speeded up until they did deliver the air. The expert went his way. When I tried to explain to the superintendent that the fans were taking more power than before, he said that I did not know what I was talking about, so I had to let it drop.

An Operating Lesson

One more thing happened at this place which taught me more about electricity than any other thing, and this was that as the plant was on the bank of the river the river once rose until the plant was under 12 ft. of water for two weeks. Of course, the dynamo and all the motors were caught and an expert was called to put them back in the proper condition. I supposed he would build a box over the machine and dry them out with steam coil or charcoal fire, but he surprised me by first taking a hose and washing out all the loose mud, and then wiping the machines as dry as possible. After that he started the dynamo with the shunt fields disconnected and the brushes off and let it run until the mud and water were thrown out. Again the machine was wiped dry and the fields connected, the brushes put on and the machine started, but the voltage was not allowed to rise above four or five volts and the main cables were connected.

I had taken it all in and had asked enough questions to fill a book. The expert was very kind in explaining everything to me. He said the reason he used current to do the drying was because it dried from the inside out and not from the outside in; also, that the hot air from the armature assisted greatly in drying the fields. The voltage punctures the insulation and for this reason it was kept low while the load or amperage was kept high to get the heat.

A Question

When he went away, he left a question with me which lasted some time. Here it is in two parts:

How much current does an ordinary 110-volt, 16-cp. light consume? Of course, I said 65 watts, in a hurry. If that is the case and the positive wire is carried to a building and supplies, say, 400 of these lamps, why should it be necessary to bring back a negative wire of the same size to the dynamo? In other words, why does the return wire on any circuit have to be the same size as the positive wire? I did not know, but told him I would find out and write him.

My books did not seem to give me much light and Ohm's law confused me, so I hunted up a couple of practical wiremen and they looked rather startled when I asked them; they told me that it was a custom. I did not believe this, so I studied all the harder and finally wrote my expert friend like this:

"Electricity is not consumed by lamps, motors or any other device, and every ampere which leaves the dynamo goes back to it. This can be proved by simply connecting the ammeter in either side. Lamps or motors are simply reducing valves which cut the pressure of the current, and this current in passing through the lamp causes the filament to heat and make light, and in passing through the motor it causes it to turn."

A few days later I received a reply saying that I was right. I do not believe he knew whether I was or not.

Why American Workers Excel

Sir Hiram Maxim said recently that he had been in England a great number of years and had been associated with firms that employ many thousands of men. It was his experience that there is never any dearth of men for positions where the salary is about 30 shillings a week, but when a man is wanted for a job requiring care and intelligence, it is hard to find them at £5 per week.

In Canada and in the United States there is a totally different state of affairs. From 1877 to 1880 he had charge of electrical work where a considerable number of young men were employed, and today nearly every one of them is in a high position.

At a works in Providence, R. I., where the very best mechanical work is produced, young men were found studying algebra and geometry while the lathe was taking a cut. In England the penny dreadful takes the place of scientific books.

While he was managing director at Erith & Crayford, Sir Hiram had a good opportunity of studying the character of the men. They were all more or less interested in cricket and in football, and it appeared that every one of them was deeply interested in horse racing. Not only this, but much of their money was spent for tobacco and drink. While the American boy is studying his algebra, the English boy is smoking his pipe.

New Type of Engine for the Burlington

The Chicago, Burlington & Quincy system has ordered five engines that are expected to handle 60,000-ton freight trains over any ordinary grade on its roads. The new engines will be equipped with automatic stokers and either slack or crushed coal will be the fuel used.

If these engines prove satisfactory, a large number will be ordered for the Galesburg division in the coal fields and for general freight traffic. They will be put in service next fall.

Good Record of English Municipal Plant

A recent issue of the *Electrician* contains a report of the power-production costs and the business done during the past year by the Manchester Corporation, a municipally owned power company which supplies light and power to the residents of Manchester, England, and also supplies the city with street lighting. By way of comparison, the figures showing the power costs for the preceding year (1909-10) are given, and indicate a decided gain in economy during the year 1910-11.

The electricity is furnished by two stations having a combined capacity of 47,300 kw. The maximum load carried at any time during the year was 37,520 kw. and the yearly load factor based upon this maximum load was 25.35 per cent.

The system represents a total capital investment of about $13,300,000 distributed as follows:

	Amount	Per Kilowatt Installed
Land and buildings	$1,895,000	$40.00
Equipment	3,500,000	74.00
Railway	394,000	8.32
Water supply	31,400	0.66
Distributing station	1,805,000	38.20
Mains	4,770,000	101.00
Meters	306,500	6.48
Motors	182,500	3.85
Electrical instruments	10,950	0.23
Cable stores, etc	148,500	3.12
Other property	249,000	5.28
Street lighting	2,795	0.06
Total	$13,295,645	$280.00

COST OF PRODUCTION

	Per Kw.-Hr.	
	1910–11	1909–10
GENERATING COSTS:	Cents	Cents
Coal	0.403	0.425
Oil, waste and water	0.044	0.044
Wages	0.103	0.122
Repairs and maintenance	0.080	0.103
Total	0.630	0.694
DISTRIBUTION COSTS:		
Wages	0.080	0.103
Repairs and maintenance	0.080	0.103
Miscellaneous	0.023	0.020
Total	0.183	0.226
MANAGEMENT COSTS:		
Salaries	0.061	0.061
General charges	.....	0.020
Special and miscellaneous charges	0.020	.....
Total	0.081	0.081
Rents, taxes, etc	0.203	0.244
Total costs (excluding capital charges)	1.097	1.245
CAPITAL CHARGES:		
Interest	0.406	0.467
Sinking fund	0.568	0.609
	0.974	1.075
Total costs (including capital charges)	2.071	2.320

The revenue for the past two years was as given in the table following:

Of this balance, $105,500 was paid into the renewals account (a supplementary provision with respect to assets having shorter estimated periods of life than the periods of statutory redemption of debt as calculated for the current year). The distribution loss was figured as 20.15 per cent.

	Amount 1910–11	Per Kw.-Hr. 1910–11 Cents	Per Kw.-Hr. 1909–10 Cents
Sale of current	$1,930,000	2.32	2.48
Rental of meters	2,350	....	....
Rental of motors	20,640	0.04	0.05
Miscellaneous	8,100	....	0.03
Total	$1,965,000	2.36	2.56
Balance above expenditures	239,500	0.289	0.24

Little's Positive Feed Lubrication Attachment

This device is designed to provide a means whereby any ordinary steam lubricator can be transformed into a positive-feed lubricator. The pump is attached to the ordinary lubricator by shutting off the pressure from the lubricator, removing the plug *A* and loosening the packing nuts *B B*, taking out the glass tube and inserting in its place the metal tube *C* so that the outlets *D* and *E* point in the direction indicated; the packing nuts *B B* are then tightened again.

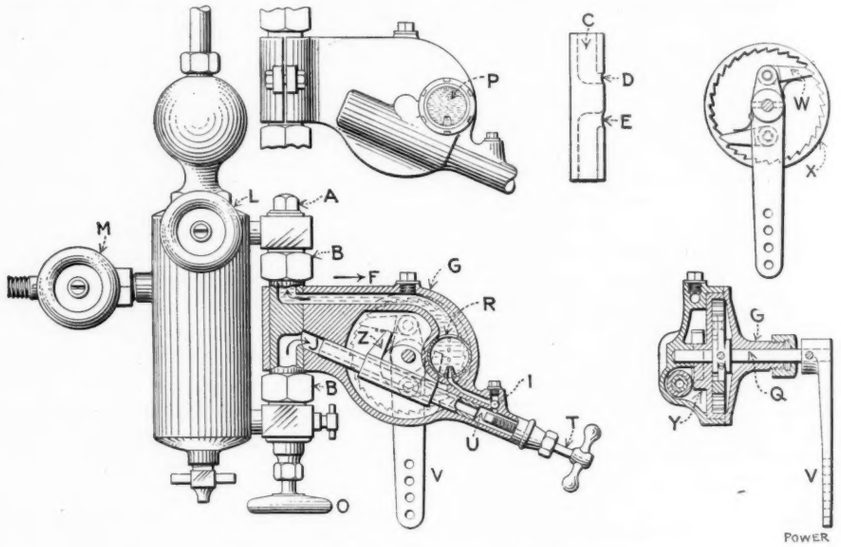
The main body *G* is then placed in position so that the inlet and outlet openings come together, thus forming the passages shown. A clamp around the tube *C* holds the body of the pump in place by means of two bolts. The lubricators can then be refilled in the usual way, keeping the valves *L*, *M* and *O* closed.

The sight-feed glass *P* and passage *R* are full right up to the outlet below the plug *A*. The swinging arm *V* is connected by a small rod and connections to the valve gear. The variation in the number of drops per minute is made by changing the end of the rod from one hole to another. The size of the drops is regulated by screwing the stem *T* in or out, thus increasing or decreasing the amount of oil that is confined in the annular space *U*.

In operation the valve *M* is opened full, and valve *L* is opened just enough to keep the lubricator supplied with water so as to cause the oil to rise in the passage *J* after the valve *O* is opened.

As the arm *V* is moved back and forth it transmits its motion through shaft *Q* and pawl *W* to the internal-toothed ratchet wheel *X*, which carries a cam *Y*. The ratchet wheel and cam are in one piece and turn free upon the shaft *Q* as the cam *Y* revolves between the two yokes *Z*, which are secured to the plunger and force it back and forth in its cylinder. When the plunger is moving in the direction of the inlet *J*, oil rises in the intake and flows in the direction indicated by the arrow and passes through the center of the plunger into the lower cylinder *U*.

When the plunger makes its return stroke, it moves forward until it meets the adjustable stem *T*, whereupon it forces the oil that is confined in the space *U* up past the ball check valve *I*, thence through the passage connecting with the nipple showing in the sight glass, then passes into the top passage, over into the steam pipe leading to the steam chest of the pump or engine.



DETAILS OF POSITIVE-FEED LUBRICATOR

This device is the invention of George J. Little, 83 Lincoln street, Passaic, N. J.

CORRECTION: On pages 178 and 179 of the Feb. 6 issue, in the article, "Various Types of Steam Meters," formulas (3) and (4) should read, respectively:

$$V = K\sqrt{h \times \frac{dw}{ds}}$$

and

$$V = K\sqrt{h \times \frac{dm}{ds}}$$

Laundry Boiler Exploded

By J. C. Callery

On Jan. 2, the boiler of the Imperial Laundry, Hamilton, Ohio, failed at the crown sheet, causing a property loss of $50,000. Fortunately none was killed.

The boiler was of the locomotive type, having a 36-in. shell and thirty-eight 3-in. tubes, each 7 ft. 6 in. long. The shell was made of ¼-in. sheets. The crown sheet was stayed by threaded ⅞-in. stay-bolts, spaced 5x6 in. apart. The safety valve was 2½ in. in diameter.

Nearly all the stay-bolt heads in the crown sheet, as well as on the sides of the furnace, were wasted away. The boiler had just been cleaned of scale, some of which was ⅜ in. thick.

It is reported that the boiler was leaking badly around the stay-bolts and tubes, and that it required considerable effort to keep the water at a proper height, but the crown sheet does not show any signs of having been burned. One stay-bolt tore out of the crown sheet, the rest, 21 in all, following immediately. Unfortunately the wreckers had removed the safety valve before an opportunity was had of examining it, but a pressure of 40 lb. per square inch was carried at the time of the accident, it is said.

Provisions had been made for a fusible plug in the crown sheet, but this had been replaced by a solid pipe plug years ago. The boiler was over 30 years old.

The building took fire, which spread so rapidly that the employees were saved with difficulty, the building being a total loss.

Boiler Explosion at Knoxville

A boiler in the plant of the Royal Marble Co., Knoxville, Tenn., exploded at 10 o'clock a.m., on Feb. 5, instantly killing two men and injuring three others. The boiler and boiler room were completely demolished. The cause of the explosion is not known.

Locomotive Boiler Explodes

By the explosion of the boiler of a heavy freight engine on the New York, New Haven & Hartford R.R. at New Haven, Conn., on Feb. 6, the engineer and the fireman were badly injured.

Smoke Abatement Movement Censured

In his address before the Electro-Metallurgical Society of Sheffield, England, Prof. J. O. Arnold took occasion to censure the smoke-abatement movement and to point out that without smoke steel is impossible.

So far as health is concerned, he said, the most mischief is caused by the household smoke, yet it is usually ignored by the smoke inspectors.

Prof. Arnold asserted that in steel metallurgy, smoke is absolutely necessary. Any operation that removes the carbon will produce poor steel. If a smokeless flame is used all the carbon is burnt out and the surface of the steel is made rotten. It is realized by many that smoke is essential to the manufacture of good steel and metallurgical furnaces are exempted, but the question of mixed stacks is continually coming up to the annoyance of manufacturers.

Cylinder Head Blows Off

On Jan. 31, at the Potter Oilcloth Works, Second St. and Erie Ave., Philadelphia, Penn., the cylinder head of the engine blew off with such force as to send it through the engine-room wall.

The engineer was stunned by the explosion and while lying helpless on the floor was literally boiled to death by the escaping steam. He was alone in the engine room at the time and the accident was not discovered until the broken engine had ceased to work and employees came to investigate the cause for the machinery shutting down.

Colors for Piping

Standard colors for pipe systems have been adopted by the Verein Deutscher Ingénieure, the Association of Miners in the Dortmund district, and the central Unions of German Heating Engineers and of German Revision Engineers. Green is to indicate water; yellow, gas; blue, air; white, steam; black, tar; pink, lyes; pink with a red ring, acid; brown, oils, and gray, vacuum. A black ring or band indicates impurity; a red ring, danger; thus a green pipe with a black ring carries refuse water; a white pipe with a red ring carries superheated steam; a yellow pipe with a brown ring, oil-gas; a yellow pipe with a blue ring, producer gas; with a green ring, water gas, etc. It is not proposed to paint the whole pipe, as this would in many cases be impracticable. What is proposed is to fix a label of sheet metal at suitable spots and intervals, indicating in addition the direction of flow and further particulars.—*Mechanical Engineer.*

Sacramento Valley Power Co. Sold

The Northern California Power Company, Consolidated, on Feb. 1, at San Francisco, bought the Sacramento Valley Power Co. for a consideration said to be $1,000,000. Prominent bankers and capitalists figure in the transaction as directors and owners in both concerns.

The country north from Chico is mainly interested in this merger proposition. The two companies have developed about 27,000 hp. and can readily increase this in excess of 50,000, because of valuable water rights.

The Sacramento Valley Co. was formed about two years ago by a consolidation of several smaller concerns and has been the only competitor of the other company in the northern counties.

The Northern California Power Co. has been in existence for a number of years and is a combination of eight smaller concerns. It supplies electric light and power, gas and water to many northern localities.

It is said the deal has been made in order to give increased light and power facilities to the northern towns at existing rates, many economies being effected by the merger.

Dinner to Charles F. Hart

On Jan. 25, at Vogelsang's, Charles F. Hart, a former vice-president of the National Association of Stationary Engineers, and now residing in London, was given a dinner by his many friends in Chicago.

The "fuel contract"—otherwise the menu—may have had a few operating features that might be objected to by the conservative engineer, but we understand that at no time were the boilers under any severe strain and that the "liquefied rivets" held tight throughout the test. The specifications for "fuel" follow:

FUEL CONTRACT

Martini Cocktail
Gives that Olympic Roll

Olives Celery
Italy and Kalamazoo have nothing on us.

Cream of Tomato
A la Boiler Compound

Tenderloin Steak, Mushroom Sauce
65,000 Tensile Strength Liquefied Rivets

Green Peas Special Baked Potato
No. 3 Mesh Superheated Spuds

Lettuce, Chicory and Tomato Salad
French Dressing
Free-For-All, make your own book on this

Brie Cheese Toasted Wafers
The Tie that Binds

Coffee
Eases the Pain of Oratory

Smoke
Immune from Prosecution

Program of A. B. M. A. Convention

At the American Boiler Manufacturers' Association's twenty-fourth annual convention, to be held in New Orleans, Mar. 12 to 15, the following papers will be presented: "Rivets," D. J. Champion, of the Champion Rivet Co.; "Compressed Air and Its Uses," Thomas Aldcorn, Chicago Pneumatic Tool Co.; "The Manufacture of Charcoal Iron Boiler Tubes," H. A. Beale, Jr., Parkesburg Iron Co.; "Boiler Explosions: Their Causes and Prevention," Francis B. Allen, Hartford Steam Boiler Inspection & Insurance Co.; "The American Boiler Manufacturers' Association as It Is and as It

Should Be," W. H. S. Bateman, sales agent, Champion Rivet Co., Parkesburg Iron Co., Chicago Pneumatic Tool Co.; "Segregation of Steel," Charles L. Huston, Lukens Iron & Steel Co.; "Modern Boiler Shops and How they Should be Equipped," H. C. Meinholtz, Heine Safety Boiler Co.

The question of uniform boiler laws will be taken up.

A ladies' auxiliary is to be formed at the New Orleans convention, and the Boiler Manufacturers and members of the Supply Men's Association are requested to bring their ladies with them. An excellent program of entertainment will be provided for the visiting members and guests.

Supply and Machinery Manufacturers' Convention

The next triple convention of the American Supply and Machinery Manufacturers' Association, the National Supply and Machinery Dealers' Association and the Southern Supply and Machinery Dealers' Association will be held at Norfolk, Va., on May 13 to 15. Convention headquarters will be at the Monticello Hotel, where accommodations for a large proportion of the delegates may be had. Other accommodations have been provided for the overflow in first-class hotels nearby.

New Publications of Bureau of Mines

Bulletin 15. "Investigations of Explosives Used in Coal Mines," Clarence Hall, W. O. Snelling and S. P. Howell, with an introduction by C. E. Munroe, and a chapter on the natural gas used at Pittsburg, by G. A. Burrell. Technical Paper 6. "The Rate of Burning of Fuse as Influenced by Temperature and Pressure," W. O. Snelling and W. C. Cope. Technical Paper 7. "Investigations of Fuse and Miners' Squibs," Clarence Hall and S. P. Howell.

REPRINTS—Bulletin 31. "Incidental Problems in Gas-producer Tests," R. H. Fernald, C. D. Smith, J. K. Clement and H. A. Grine. Reprint of Geological Survey Bulletin 392. Bulletin 32. "Commercial Deductions from Comparisons of Gasoline and Alcohol Tests on Internal-combustion Engines," R. M. Strong. Reprint of Bulletin 392. Bulletin 33. "Comparative Tests of Run-of-mine and Briquetted Coal on the Torpedo Boat 'Biddle,'" W. T. Ray and Henry Kreisinger. Reprint of Bulletin 412.

The bureau has these publications for free distribution, but can give only one copy of the same bulletin to one person. Order by number and title, and apply to the director of the Bureau of Mines, Washington, D. C.

Engineering Books in all Fields

The McGraw-Hill Book Co. announces the completion of arrangements for the sales agency of the technical books of the *Railway Age Gazette, American Engineer* and *Signal Engineer.* This makes the company publishers and distributors of books for the three journals, but it does not affect the publication of the papers themselves in any way. With the addition of these three papers in the railroad field, the company now publishes books for the twelve leading American engineering papers in the fields of civil, mechanical and electrical engineering, electric and steam railroading, machine tools, mining, metallurgy, chemical engineering, etc. The papers now represented are *American Machinist, Engineering News, Electrical World, Railway Age Gazette, Electric Railway Journal,* POWER, *Engineering Record, Engineering and Mining Journal, Coal Age, Metallurgical and Chemical Engineering, American Engineer* and *Signal Engineer.*

NEW PUBLICATION

KONDENSWASSER-ABLIETER (Steam Traps). A Comparison of the Various German, English and American Types. Their Construction, Operation and Maintenance. By Robert Wagner. Published by Hochmeister & Thal, Leipzig, 1911; 424 pages, containing 484 illustrations.

In this work, which is as yet available only in the original German, Mr. Wagner has not attempted to present any new ideas on the subject of steam traps, but has written it to fill a gap which he considered existed in technical literature.

With considerable attention to detail, he reviews the entire field of steam traps in a more or less encyclopedic manner, discussing their purposes, uses and maintenance and the calculation, construction and selection with regard to specific requirements. His study comprises the German, English and American types, which he compares in relation to their construction, effectiveness and maintenance. He points out that a good many mistakes are being made in the application of the steam trap; the book is written therefore from a practical standpoint with a view of aiding practical men in their choice of this apparatus.

The first three chapters are devoted to a general discussion of the phenomena of condensation, the process of the accumulation of water, and the separation of water from the steam. The author then goes on to explain the conditions under which this takes place and the disadvantages, evils and dangers of condensation and its prevention.

A chapter is devoted to the installation and care of steam traps, followed by another on the calculation and construction of traps, thus giving, in a brief way, a theoretical background for the author's fuller treatment of the various types of traps in use. Throughout the rest of the book he discusses various types in detail, with appropriate pictures, drawings, diagrams and tables; he goes into the construction, advantages, disadvantages and peculiar uses to which each type can be put.

The book would be valuable if it accomplished no other purpose than that of bringing together in a single volume all that has been achieved in this particular branch of steam engineering; but in view of the extensive use of steam for various purposes, such as power, heating, etc., in modern industries, the author has supplied a real need in the way of offering a ready-reference book for the user as well as for the constructor of steam traps. The work is written in a clear, concise and popular style which even the layman will find readily understandable.

SOCIETY NOTES

The American Association of Boiler Inspectors will hold its annual dinner at the Broadway Central Hotel, New York, on the evening of Feb. 21.

The New York State Association, N. A. S. E., will hold its seventeenth annual convention in Yonkers on June 14 to 16. The Getty House will be the headquarters and the sessions will be held in the Armory, Waverly St. Plans are laid to have a large manufacturers' and dealers' exhibit.

PERSONAL

W. M. Vreeland, formerly chief engineer of the Celluloid Co., Newark, N. J., has accepted a position as chief engineer in the plant of L. Bamberger & Co., Newark, N. J.

J. M. Tomey, formerly with the Prudential Life Insurance Co., has been appointed chief engineer of the new Central Commercial and Manual Training High School at Newark, N. J.

Howard W. Evans has been engaged by the Best Manufacturing Co., Pittsburg, Penn., and will hereafter supervise its sales, order and engineering departments. Mr. Evans is a specialist in piping materials. He formerly occupied a similar position with the Crane Co., Chicago, Ill.

E. T. Adams, who was in charge of the gas-engine work of the Allis-Chalmers Co. when the great engines for Gary and South Chicago were built, is said to have interested himself in the Grine oil gas producer, described in our issue of Nov. 14, and to have effected improvements which will insure its commercial success. The Wisconsin Engine Co., of Corliss, Wis., of which Mr. Adams is president, is said to have acquired the patent rights and to be arranging for the introduction of the producer upon a large scale.

Moments with the Ad. Editor

One hears about thought transference—about projecting one's thoughts into another man's mind—and marvels.

As a trick or amusement it can't be equalled—

As an adjunct to a modern business it isn't worth one iota.

One cannot employ a telepathist to project a thought—without words—to 30,000 or 40,000 people, at so much per projection.

One cannot "wish" a man into buying anything without giving him some tangible "reasons why."

Yet there are manufacturers who unconsciously seem to have this idea.

They think that because *they* know a thing to be so—that their knowledge naturally is common knowledge.

They think that because they make a good device the world will become aware of it without their going to any trouble telling about it.

But this class of manufacturer is rapidly becoming converted—he is gradually coming to see that the only way to reap a harvest is to harness modern methods to his business.

The bulk of the manufacturers of power-plant devices *know* that the power-plant man buys only upon solid, can't-get-away-from facts.

They know that power-plant men do their own thinking, that they do their own selecting, and that when they select, it is only because the device in question has been proven to be one they need—

For the saving it will effect, or for the improved work it will help accomplish.

And consequently these manufacturers tell you, in the Selling Section of your paper, the points that make their devices better, more serviceable, more economical.

They *show you* why their goods *should* be used, and they let *you* be judge as to whether or not their goods should be used in *your* plant.

These are the manufacturers who are "reaping the harvest."

They tell their stories in such a way that you can't help but get valuable ideas from them.

They put you in the way of thinking up ways and means of lessening expenses, and increasing efficiency—

Which means progress for you *personally*.

These are manufacturers you should listen to with much attention.

Their talks are meaty, full of real arguments—they do not depend upon "mental telepathy" to sell their goods—

They have the "reasons why" and are not afraid to tell them to *you*.

Go through this Selling Section carefully and prove these things to your own satisfaction.

NEW EQUIPMENT

The installation of a new electric-light plant, at Minden, Neb., is contemplated.

The local electric-light plant at Bancroft, Ont., was recently destroyed by fire.

Meyersdale, Penn., is considering the installation of a municipal electric-light plant.

Meigs, Ga., is considering the installation of a municipal electric-light plant, to cost $5000.

Tampa, Fla., is considering improvements to its water-works plant. D. B. McKay is mayor.

Wolcott, N. Y., is considering the construction of a water-works system. Estimated cost, $35,000.

Oxford, Ohio, is contemplating the installation of a 300-hp. boiler in the municipal electric-light plant.

Muskegon, Mich., will install three new boilers in the municipal pumping station. Harry Beck is city engineer.

The Aberdeen Railway Co., Aberdeen, S. D., will construct a new power plant. N. Herreid is general manager.

The Washington Union Coal Co. will construct a power station, at Tono, Wash. Estimated cost, $250,000.

The Alpine Power Co., Alpine, Tex., is considering improvements to its power plant. J. L. Crawford is president.

The installation of an electric-light plant at the Los Angeles Military Academy, Bairdstown, Calif., is contemplated.

The Texas Electric Co., Dallas, Tex., has been incorporated to build a power plant. J. V. Watkins, Dallas, is president.

The construction of an electric-power plant, at North Brookfield, Mass., is being considered. Frank E. Winchell is interested.

The U. S. Reclamation Service is contemplating the construction of a power plant, at Palisades, Colo. John Page is engineer.

The Consolidated Lighting Co. will install a 2500-kw. generator in its power plant, at Montpelier, Vt. H. D. Larabee is manager.

The Northern Ohio Power Co., Akron, Ohio, will build a new power house, at Cuyahoga Falls, Ohio. C. H. Howland, Akron, is president.

Norwich, Conn., is considering the installation of a 2000-kw. turbo-generator unit at the municipal electric plant. Estimated cost, $37,000.

The Falls City Electric Light & Power Co., Falls City, Ore., will install a new dynamo and generator in its plant. W. E. Newman is president.

The Mansfield Ice & Light Co., Mansfield, La., will make considerable improvements to its ice and light plants. D. G. Petty is president.

Conemaugh, Penn., is considering several improvements to the municipal electric-light plant. William F. Albright is superintendent of plant.

Mount Forest, Ont., will install a 100-kw., 133-cycle, 1100-volt generator, in the municipal electric-light plant. John Morris is superintendent.

The Lancaster Electric Light Co., Lancaster, Wis., will install a new dynamo and engine in its plant. J. G. Harshberger is vice-president.

The Montreal & Southern Counties Ry. Co., Montreal, Que., is considering the construction of a new substation. W. B. Powell is general manager.

The Minetto-Meriden Co., Minetto, N. Y., will construct a two-story addition to its power plant. A. S. Coffin, 109 Rand St., Chicago, Ill., is architect.

Wagoner, Okla., is making preliminary arrangements for the installation of a municipal electric-light plant. R. R. Harrison is light commissioner.

Owen Sound, Ont., is considering the installation of a 500-kw. steam turbine, in the municipal electric-light plant. J. R. McLinden is manager of plant.

The Idaho-Oregon Light & Power Co. will construct an electric-light plant, at Huntington, Ore. O. G. F. Markhus, Boise, Idaho, is general manager.

Bids will soon be received for the construction of a power house for St. Vincent's Home, at Seventeenth St. and Woodland Ave., Philadelphia, Penn.

Bids will be received by the United States Reclamation Service, Department of Interior, Fallon, Nev., until 4 p.m., Feb. 26, for an electric-power shovel.

Gunnison, Colo., will receive bids until Feb. 21, for the construction of a water-works plant. Burns & McDonnell, Kansas City, Mo., are consulting engineers.

Clarksville, Ark., will receive bids until Mar. 1 for the construction of an electric-light plant. W. N. Gladstone, Fayetteville, Ark., is consulting engineer.

Plans are being prepared by Crum & Davidson, Frederick, Md., for the construction of a water-works system at Walkersville, Md. Estimated cost, $50,000.

Burns & McDonnell, Kansas City, Mo., are preparing plans for the construction of a municipal electric-light plant, at Minneapolis, Minn. Estimated cost, $15,000.

The State Board of Control, Sedro Woolley, Wash., will receive bids until noon, Feb. 20, for the construction of a power plant, at the Northern Hospital for Insane.

The Miami Electric Light & Power Co., Miami, Fla., is considering the construction of an addition to its power plant. John N. MacGonigle, Jacksonville, Fla., is superintendent.

The Great Shoshone & Twin Falls Water Power Co., Twin Falls, Idaho, will enlarge its power plant, at Shoshone Falls, D. C. MacWatters, Milner, Idaho, is general manager.

Lansing, Mich., is considering the expenditure of $46,000 on improvements and additions to the municipal electric-light plant and water-works system. C. A. Cable is chief engineer.

The Syracuse Lighting Co. will construct substations at Marcellus, Marcellus Falls, Skaneateles and Skaneateles Junction, N. Y. J. C. De Long, Syracuse, N. Y., is general manager.

The Madison Light & Fuel Co., Madison, Ind., has incorporated, to take over and reconstruct the Madison gas and electric-light plant. Earl F. Potter, Willard C. Bevine and Henry L. Hanley are the incorporators.

The Scranton Electric Co., Scranton, Penn., will install a 7500-kw., 60-cycle, four-wire, 4000-2300-volt generator, two 2000-kw. alternating-current synchronous motors and a 750-kw. direct-current balancer set. D. T. Campbell is manager.

The city commissioners of Calgary, Alta., will receive bids until noon, Mar. 15, for one 2500-kw. turbo-generator, one 1000-kw. synchronous motor generator, one 50-kw. and one 25-kw. motor-driven exciter. J. M. Miller is city clerk.

BUSINESS ITEMS

James B. Brady has been elected vice-president of Manning, Maxwell & Moore, 85 Liberty St., New York, in place of W. O. Jacquette, resigned.

The George M. Newhall Engineering Co., Philadelphia, Penn., have removed their general offices to 807-8-9 Morris Building, 1421 Chestnut St.

The Delaware Water Co., Delaware, Ohio, have purchased another set of MacDonald shaking grates from the Robb Engineering Co., Ltd., South Framingham, Mass.

Walter A. Giles, formerly with the Locke Regulator Co., Salem, Mass., is now with the Consolidated Engine Stop Co., and represents them in the Pittsburg, Penn., district.

The Terry Steam Turbine Co., Hartford, Conn., is now installing in the Far Rockaway plant of the Queensboro Gas & Electric Co. two high-pressure type blowers direct-connected to Terry non-condensing steam turbines.

The York Manufacturing Co., York, Penn., has sold, since Nov. 28, 1911, 18 ice-making plants, aggregating a total of 653 tons of ice daily, and 58 refrigerating plants aggregating a total of 1219 tons of refrigeration daily.

The Danubil Packing Co., 253 Broadway (G. G. Schick) has closed contract with the Navy Department for its entire supply of sheet packing. This contract was awarded after severe competitive tests extending over a year.

The Ashton Valve Co., 271 Franklin St., Boston, Mass., manufacturers of gages and pop safety valves, have added to their line the Ashton sanitary bubbling drinking fountain and will send descriptive bulletins to all interested.

Stephen M. Hall, Massachusetts Institute of Technology, Class 1900, formerly with the Garwood Electric Co., has associated himself with the Consolidated Engine Stop Co., Thirty-eighth St. and Ninth Ave., New York, as general sales engineer.

Owing to the increasing use of hydraulic presses and the steady growth of its business the Watson-Stillman Co., 50 Church St., New York, has found it necessary to make an immediate extension of its manufacturing facilities. To take care of business increase it was considered advisable to reorganize the board of directors. The new officers elected are Francis H. Stillman, president (reëlected); E. A. Stillman, vice-president; J. P. Bird, treasurer; A. F. Stillman, secretary and works manager, and Carl Wigtel, chief engineer.

The contract for the entire equipment of Power House No. 1 of the Los Angeles Aqueduct Hydro-Electric Project has been awarded to the Westinghouse Electric & Manufacturing Co., East Pittsburg, Penn. There will be installed three 9375-kva., 6600-volt, 50-cycle, three-phase waterwheel generators running at 200 r.p.m., and two 250-kw., 250-volt direct-current waterwheel generators used as exciters; ten 3150-kva., single-phase, 50-cycle oil-insulated water-cooled transformers for raising the generator

voltage (6600) to that of the transmission, 60,000. In the substation there will be installed nine 5000-kva., single-phase, oil-insulated water-cooled transformers for stepping down the transmission voltage to either 33,000 or 16,000 for secondary distribution.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

ENGINEER for power plant. Address J. S. Eckert, superintendent Rock County Sugar Co., Janesville, Wis.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

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SITUATIONS WANTED

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ENGINEER or superintendent of small electric power plant; eight years' experience, producer gas, oil or steam; employed at present, but desire change; good reasons; married, sober and capable of rebuilding plant if necessary; state salary. Address Box 581, Power.

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EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. M. Y. C., 1417 W. Jackson Blvd., Chicago, Ill.

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FIVE CORLISS vertical water leg, and sixteen Manning vertical type boilers. J. P. Coats, Ltd., Pawtucket, R. I.

8x10 SKINNER ENGINE, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator . Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ONE SMITH VAILE triplex pump, size 5½x8, direct-connected to Stanley alternating current, style 1-75 hp. motor, three-phase, 60 cycles, 720 r.p.m., 440 volts, 10 amperes. C. & W. I. R.R. Co., Geo. L. Pollock, P. A., Chicago.

LATEST MODEL, heavy duty, 18x42 Brown engine, installed 1904; no reasonable offer refused; this engine was operated by builders' engineer; for sale account of removal; splendid equipment, oil guards, lubricators, metallic packing. Box 575, Power.

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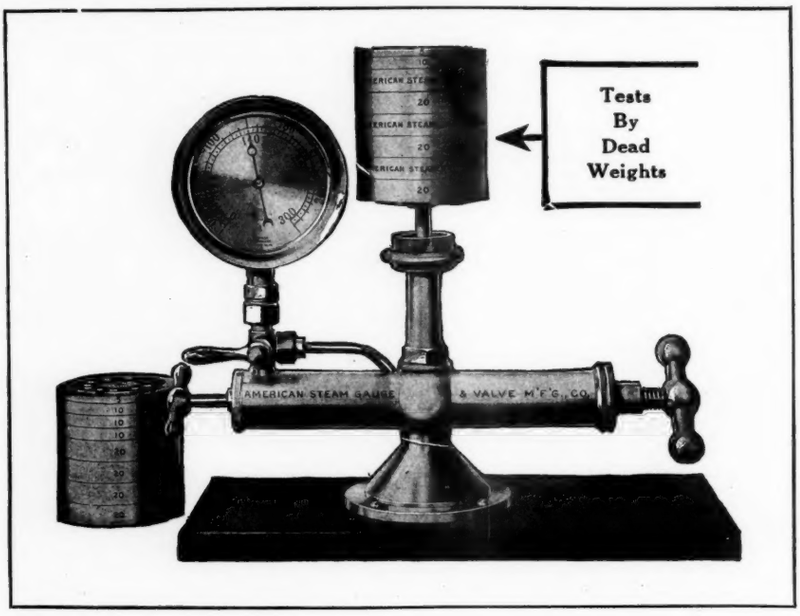

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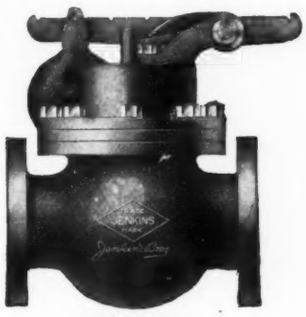

Fig. 158a
With Piston and Air Cushion, and Lever and Ball, as regularly made in sizes 3 inches to 10 inches.

They are extremely sensitive and work freely without the slightest jar or pounding.

The piston and air cylinder are as carefully fitted as in the best steam engines, and, working in connection with suitably arranged air valves, the main valve is cushioned and made absolutely noiseless under all conditions.

They are made in sizes 4 to 24 inches inclusive, with wheel, chain and weight, as shown in Fig. 158. Sizes 3 to 10 inches are also made with ball and lever as shown in Fig. 158a. When the back pressure to be carried is over 4 pounds, we advise the use of the chain and weight design, Fig. 158. Sizes 3 to 12 inches are either screwed or flanged.

Like all genuine Jenkins Bros. Valves the above can be obtained at most good dealers. Ask your dealer to supply you. We will be glad to forward you a copy of our latest Catalog direct upon request.

Fig. 158
With Piston and Air Cushion and Chain and Weight, as regularly made in sizes 4 inches to 24 inches.

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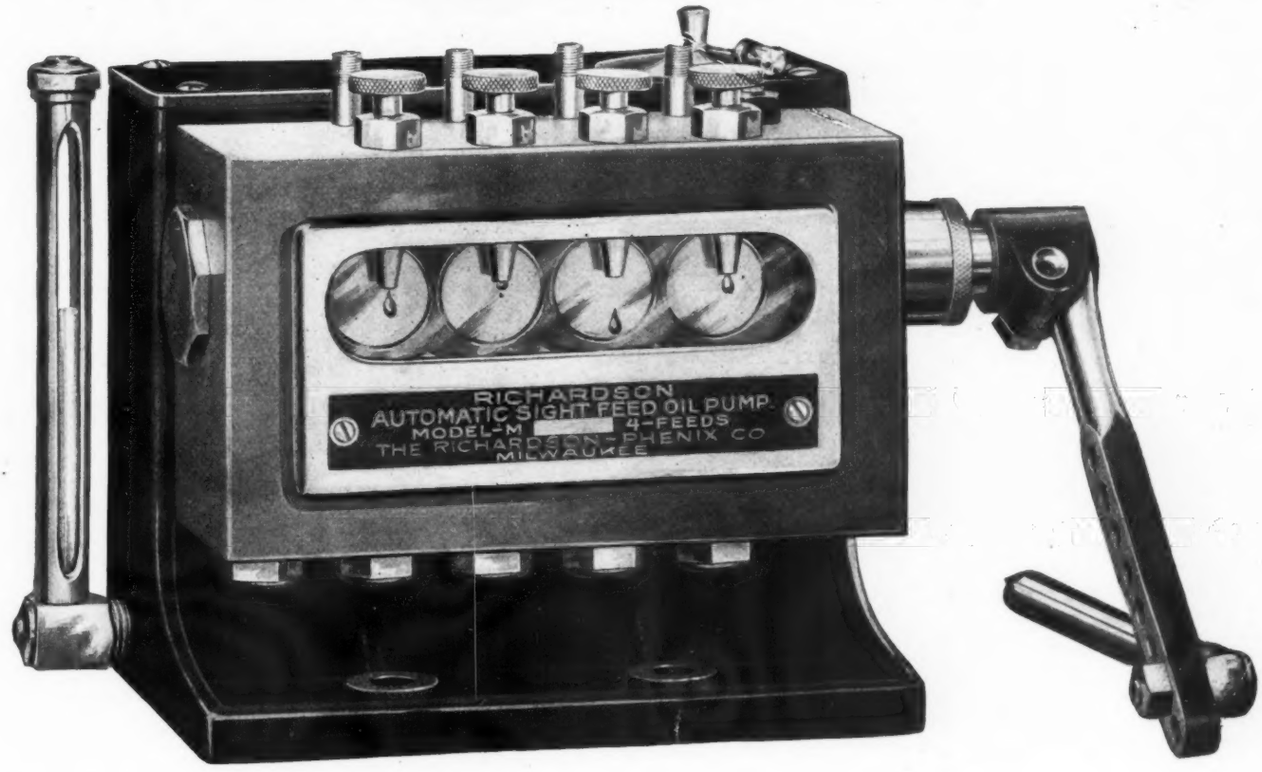

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